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THE SLEEP OF INSECTS; AN ECOLOGICAL STUDY.

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An object in motion always attracts the attention of children, young and old; a butterfly flitting from blossom to blossom, a locust jumping before one in the dusty road, a bee rummaging in a flower, all arouse one's interest. But naturalists, like children, cease to pay attention to insects when the latter cease their activity. Thus the interesting problem of when, where and how insects sleep has been all but neglected.

The claim of this problem upon our attention is undeniable when we consider the importance of the period of recuperation in the life of all of the members of the organic world. The sleep of plants, or even the sleep of cotyledons, has been made into charming classics by Darwin and others; how much more interesting ought to be the sleep of animate objects.

The records of this phase of insect life are meagre and isolated, and are only incidental observations. The only purposeful study on the sleep of insects has been done by Fiebrig. This excellent paper is unique in that it deals with the physiological condition of insects during sleep, whereas the other observations and the present study are of an ecological nature.

Our observations were made entirely in the field, sometimes after dark with an acetylene lamp, but more frequently between twilight and darkness. The latter method yielded the more attractive results since the behavior could be noted when they

were preparing to retire, while in the former one could learn but little more than the position of the insect in relation to its surroundings when already asleep. A few early morning trips afield were very productive.

WASPS.

Chalybion cæruleum Linne.

A congregation of about thirty of these steel-blue wasps was discovered on the under side of an overhanging rock on the bluffs overlooking the Meramec during July, 1908. It was about 10:30 o'clock in the morning and very dark, due to an approaching storm. It was puzzling to see these wasps, usually of solitary habit, all huddled together in a very small space. They were inactive but alert enough that when an attempt was made to take them they all flew away, but soon returned to the same spot. Three times they thus persistently returned to the identical spot when disturbed. The mud nests of this species are usually situated in a sufficiently sheltered place that it is not necessary for the wasp to seek shelter elsewhere; hence there must be some other reason for each one leaving her solitary nest and all coming together with one accord and seeking the appointed meeting-ground and the company of others. There were many other sheltered nooks among the rocks, but no isolated wasps were in them; this leads one to believe that this assemblage was not due to mere accident.

In 1913, I had another opportunity to study these wasps at Lake View, Kansas, and the results of these observations proved that gregariousness in a modified form does occur in this species. This wasp is not gregarious as is the cockroach, spending almost every hour of its life in the community of others, but in a more anthropomorphic sense. Our nervous little blue wasp only after a day's hard toil of gathering mud and constructing her nest of it mouthful by mouthful, of hunting and paralyzing and carrying home a supply of spiders, at the close of day leaves her work and seeks the chosen spot, there to enjoy the company of other workers who have gathered there likewise to spend the night. The males were also there in numbers equal to the females, but how or where these shiftless fellows spent the day, no one knows.

On July 2, at 7:45 a. m., a number of these blue wasps were found assembled on the ceiling of an open cow-shed. The wasps here had collected in two groups about four inches apart, and a few individuals dotted the intervening space; during the next few minutes they flew away one by one to their day's business after having spent the night there. I watched the spot during the day but none of them returned; at dusk however, they began to arrive, and lo and behold! they settled on the same spot and collected in two groups similar to those of the morning.

I waited until almost dark, and when they were fast asleep I removed about half of them with the forceps to ascertain if both sexes commingled. The twenty insects which I took were 9 males and 11 females. In attempting to take these wasps earlier in the evening when they were not fully asleep, I found them to be more than usually nervous and ever ready to fly away. Sometimes when an attempt was made to take one, simultaneously as if by magic all flew away, but when they were asleep the task was easy; sometimes one grasp with the forceps brought down three insects. Close observation showed that none were in copulo.

I resumed these observations when I again came to the farm six weeks later. I then found a much larger congregation on the same ceiling and the identical spot; they were probably the ones I had left and many newcomers. There were a hundred or more crowded into an area of less than one square foot, and again I noticed that while it was yet slightly light my gentlest approach would invariably start them to flight simultaneously as if by signal, and I sometimes even wondered if they had not a sentinel on watch. When these wasps are engrossed in building or provisioning their nests one can observe them quite closely without arousing such a reaction. On this particular evening they were disturbed three times and each time they left simultaneously, but invariably they returned one at a time.

Careful examinations at various times have convinced me that mating does not occur during these meetings, although both sexes are always present, usually in equal numbers. I have never been able to detect any evidence of their mating in the evening or morning, and during the hours of darkness they are in such deep sleep that they are dead to all the world about them. Possibly they meet here preparatory to the marriage flight when the sun is high.

One morning we took about fifty of these wasps from the ceiling and marked them with paint, to see whether the same individuals returned night after night, and for how long a period. During the next three nights from six to nine marked insects could be distinguished in the clusters. Even so small a proportion as this demonstrates that the same wasps returned to the appointed spot night after night. Doubtless some of the wasps succeeded in cleaning off the marks, and others were probably mortally injured by the forceps or the paint. It was interesting to see that on the first and second night thereafter most of the marked insects took their position on the ceiling to the rear of the joist, a position never taken before (the sacred spot was just in front of this joist), but on the third night even these had become fearless again and joined the main body. Two weeks later, upon leaving the farm, I picked up 38 of the insects to take with me, (19 males and 19 females) and to my great surprise two of them still retained markings of sufficient distinctness to identify them, thereby proving that at least a part of the insects faithfully returned to the roosting place for two weeks or more.

What explanation can there be for this diversity between the habits of *C. caeruleum* and of *Pelopœus caementarium*, a wasp very similar, who builds nests which are indistinguishable from those of this species? The one is gregarious at night, and the other, after a day's hard labor of exactly the same kind, seeks solitary shelter under some friendly leaf.

This discovery that the blue wasps congregate at night solves the problem of the group under the rock at Meramec Highlands. When the sky became clouded and darkness fell over the earth at mid-day, this afforded sufficient stimulus to prompt the wasps to hie them to bed, in much the same way as darkness affects poultry.

This work suggests many interesting problems: Is this gregarious habit at night an incipient stage to higher development and socialization, or is this condition a vestige from the time when they or their ancestors were social insects?

Since the female alone works hard at nest-building and provisioning, what becomes of the male during the day, where does he go, and how does he spend his time?

Since it seems that mating does not occur during the night and since the female is busy at her work during the day, when

and where does mating occur, and is more than one union necessary?

Has this gregarious habit been acquired as a means of protection and mutual guarding, since the sting of this insect is very mild?

Sceliphron (Pelopœus) **cæmentarium.**

Even in localities where *S. caementarium*, the common mud-daubers, occur in abundance, I have only once been able to discover how they sleep and where they spend their nights, since they do not remain on their nests after working hours. During the summer of 1915, from June 1 to 5, two mud-daubers returned each night to two distinct elderberry bushes, and while they did not always take the same branch they usually occupied each the same plant. Night after night I watched them until nearly dark, and found that as it became darker they grew quiet and so remained, resting on the foliage in an easy but not exaggerated posture.

One day late in May it suddenly became cloudy and quite dark at mid-day, and a few drops of rain fell. At this time I discovered eight *Sceliphron* on the elderberry bushes, intently walking up and down the stems. In a few minutes the sun shone brightly again and they flew away. I watched the bushes for their return, but they did not appear. Soon after that another cloud darkened the sky, and four wasps promptly reappeared. They walked about nervously on the stems, and when the rain fell fast they all flew away, probably to better shelter. They may have been only seeking prey; if they were really seeking shelter, they certainly would have found better at their nesting-sites.

On several evenings some of these wasps accompanied *Sphex* (*Ammophila*) *pictipennis* to their regular sleeping places on the elderberry bushes, but each time they soon wandered elsewhere. (see p. 231).

Sphex (Ammophila) **pictipennis** Walsh [S. A. Rohwer].*

In my garden are three elderberry bushes fifteen feet apart. At this particular stage of growth they all bore unripe berries. I mention these facts in detail because while the plant was comparatively abundant in the vicinity it was on one bush, the

*Following the suggestion of Dr. Cockerell in the Ent. News, we place in brackets the name of the gentleman who kindly identified the species for us.

middle one, and on only one cluster of green berries that certain sleeping performances of *Sphex pictipennis* were staged.

At twilight, July 14, 1913, three insects were resting on this umbel of berries. They were just beneath the spray; their position was horizontal, their mandibles locked around the petiole of the berry, and most of their legs were hanging free in the air. In this they practically agree with the observations by Mr. Banks. He notes them in a horizontal position on the tall grass, holding on by the mandibles, but with the legs touching the stems.

At first, the insects were disturbed by my presence, but later in the evening they showed no signs of consciousness of me when I pressed close enough to ascertain that the mandibles merely formed a circle around the stem, and did not bite or pierce it or draw out its juices. All three were females. They had to be taken up with the forceps in order to ascertain the sex; one was kept for the cabinet and the other two were replaced but they were too sleepy to hold on and both fell to the ground, and could only summon enough energy to creep half way up again. At 7 o'clock the next morning they were in the same places, but highly alert; when I approached within five feet of them they were up and away, while only a little while before they had been too sleepy for self-protection. After the rough handling they had undergone in the examination I hardly expected them to return, but to my surprise at 6 that evening I found on the identical cluster not alone these two but three additional ones also. From 6 until 7:30 they were nervously walking about on the cluster and twig. The antennæ were actively in motion. Several times they flew to a near-by bush, but always returned soon to their original cluster. At one time they were followed by two *Pelopoeus caementarium*, but these soon left. At 7:30, however, they all seemed to be quietly at rest in their characteristic positions on this chosen spot.

Had these two wasps then really communicated with the other three and induced them to sleep on the same bush? Or had these three followed the original two? Or had these five arrived at the same spot by mere coincidence? Let me say that I could perceive no sociability among these five wasps; while it was still light each nervously examined the vicinity independently, and finally sought a resting place on this one cluster, from one to three inches apart. Therein they differed from *Chalybion*.

I then decided to mark them to see whether the insects coming each evening were really the same ones. It was very near dark, and an inartistic piece of work it was, but they must have been in deepest sleep, for they were motionless while I applied the paint. At midnight not one of them had moved an iota, and they were so lost in slumber that when the candle was brought very near to them it aroused not the slightest response. The next morning found them in the same position; one by one they awoke, rubbed their antennæ as a sleepy child rubs his eyes, and independently flew away without ado, the last one leaving at 7:30.

At 4:30 that afternoon, (July 16), a vigilent watch was begun to see if the marked individuals would return, and if so whether they would come in a body or singly as they had gone forth. At 5:30 one wasp arrived and a half-hour later two more. Two were marked insects, and the third was a stranger. All hovered about from twig to twig and sometimes flitted off to other bushes for a brief sojourn, but the two marked individuals returned frequently to their favorite spray. At dusk the two were settled and ready for sleep in the accustomed place, but the stranger, probably finding the situation not to his liking, sought other quarters and was seen no more. The next morning the two sleepers were just as I had left them. That night the incidents were repeated in every detail, the two marked wasps (they were females) finally remaining and the stranger departing. On the succeeding night, however, only one of the marked wasps appeared to spend the night in the accustomed spot. Again a stranger, perhaps the one already mentioned, accompanied her and in the usual fastidious manner examined the twigs and found the place unsatisfactory and hied itself to another berth.

The next evening, July 19, the two marked wasps and the guest again returned and all of them again buzzed about their particular green cluster, and as usual the stranger departed. But the two old residents this time sought a place on two distinct bushes. A new situation had arisen this evening, however; a lot of disgusting, newly-hatched Hemiptera (*Anasa tristis*) were actively occupying the favorite spray. Hence we cannot be surprised that the two wasps, finding their abode usurped and their peace disturbed, departed after a short visit to other bushes. The one which had spent the night elsewhere gave no evidence to account for its wanderings.

I watched for these old residents every day, but it was not until a week later (the Hemiptera were by that time gone) that one returned to the old home to spend the night, but if it had been marked the paint had worn off. I did not want to frighten it away by marking it. The next evening, July 28, I found three wasps here, all unmarked, but they were more skeptical than ever (as would be expected of first-nighters). Every time I approached them they flew away, but persistently returned. I tried to find marks on them but could not; they may have been my lost friends with their identification marks rubbed away. I could not bring myself to annoy them with markings, so I left them, hoping they would return with their friends the following night, but they returned no more.

Later in the season, October 7, I saw three wasps of this species asleep out in the field. Here too they were in their characteristic position, the body stretched out horizontally, the mandibles encircling a twig and most of the legs hanging free in the air while the others lightly rested, in a casual way, upon the twigs beneath. Two were on sweet clover and one on goldenrod. Others of both sexes were seen during the last half of August, in the regular position upon erigeron or white snakeroot. One was found hanging vertically by the mandibles. Their way of spreading out their legs in the air may be a form of relaxation.

Elis 6-cincta Fabr. [S. A. Rohwer].

These wasps are probably parasitic upon certain beetle larvæ; they build no nest, but sting their prey in its natural habitat, deposit an egg thereon and leave it.

On a hot day in July, 1912, we found at 4 p. m., hundreds of *Elis 6-cincta* at rest on the partly submerged vegetation of a temporary pond. When we neared them they all flew away but eventually returned. The remarkable aspect of the affair was that all of them were males. We supposed that the excessive heat of the day had driven the males to rest early, and that the females would soon follow. No similar congregations were to be found on the surrounding vegetation, although this field abounded in both sexes of this species, and especially the females were plentiful and at work on the white flowers of the melolotus at the time that these males were at rest.

In August of the following year at Lake View, Kansas, sufficient observations were made on the sleeping habits of these insects to prove that in this instance the males had not congregated for the purpose of meeting the females, but that the males alone of this species are gregarious in habit, and perhaps all in the region 'round about occupy one centrally located sleeping place.

One such colony we discovered asleep on a clump of *Aster multiflora*. The plants were two feet high, and with their low, spreading branches covered an area of two by three feet. They were three feet from a small creek and about ten feet from a high mud bank on the other side. Although for a good many evenings we examined all the vegetation in this vicinity we found no sleeping *Elis* elsewhere. Only the males occupied this bush, and only at night; they did not use it as quarters for mid-day rest.

While it was still a little light these too were shy and were easily frightened away, but before night they crept back one by one to their own roost. Several times each night for several nights I gently stirred the bush to see them scamper off, but always when I returned after an absence of fifteen or twenty minutes the bachelor quarters were again filled. These oft-repeated disturbances did not discourage them. For a period of five nights and mornings I examined this bush and saw only males, but still I thought that closer examination surely *must* show a few females present. So early one morning, when just a faint streak of daylight was appearing, I found all on the bush fast asleep, and with rapid sweeps of the net I took about one-third of them, 105 individuals; there was not a female among them. Even while I was picking the insects out of the net some of those which had escaped returned to the bush; even the commotion of sweeping the bush had not permanently frightened away those which had escaped me, and the bush was again teeming with inhabitants.

The following details for 1914, both at St. Louis and in Kansas, show that the sleeping conduct already recorded is not due to local or environmental conditions, but that their behavior is constant despite the intervention of time and space.

On July 18, at Lake View, Kansas, another large colony was discovered still asleep at 5:30 a. m. I shook the plant vigorously to note their behavior; they did not fly high in the air as they

do early in the evening, but dropped to the grass below, spreading their wings to ease their descent. Here we have at once conclusive evidence that this massing together of great numbers does not afford protection from the birds, because they all behaved thus stupidly, making no effort to escape when attacked at an hour in the morning when the whole bird population is alert and riotous with activity. I cannot say whether the weather, light or some other factor caused their behavior to differ this time from the previous morning experiment.

About the middle of August a colony was found in a clump of *Erigeron canadensis*. Night after night they returned to these same four or five stalks, several hundred strong, and all males. The whole made a pretty group; the tall, stately plants were in themselves graceful; the stem for about one-third of its length was literally covered with the delicate, bright-colored bodies, while each slender leaf bore one, or occasionally two, on its lower surface.

On August 13, it was cloudy and dark at 6:30 a. m. About two hundred males of *Elis 5-cincta* were still asleep on five plants of *Erigeron canadensis* within a radius of three feet. They were ranged without crowding in single file on the long, narrow leaves and stately stems. When disturbed they dropped languidly to the lower leaves or the ground.

The next morning the gloom continued. At 10:15 a. m., the *Elis* still remained on their customary sleeping-quarters, too indolent to bestir themselves on a dull day. By 4:30, a high wind was blowing; they were rocked violently to and fro on their tall stems without being stirred to flight, but the approach of my forceps at once caused turmoil among them. By 6:30 the sun shone brightly, but *Elis* remained at home.

On the same dull day three other colonies were found on the under side of the broad leaves of some weed, but I cannot say whether this was their regular sleeping quarters or whether they had thus come together for only temporary shelter from the threatened storm. One group comprised 25 individuals, another 15 and the other 12.

A thick mass of weeds, especially Erigeron, bordering a large, open space of ground, seems to be a favorite habitat of *Elis*. In the middle of one such spot about two hundred yards in length, we found a crowded clump of 27 plants each bearing

from 2 to 60 males. Although it was past seven o'clock on an August morning and the sun was high, all were still at rest.

At 5:30 in the afternoon, while it was yet full day, I examined two large dormitories of *Elis* and found almost all of them in their sleeping position already, although they were yet very susceptible to even a slight movement at some distance. One of these groups occupied certain plants in the heart of a clump of Erigeron. By 7:05 o'clock when I returned to the place they were at rest on these plants in great numbers. Suddenly, without apparent provocation, they all arose and flew about in circles for several minutes before they again settled. Some cause other than myself was responsible for the disturbance, for I stood fifteen feet away. The behavior was the more strange because they had become well settled in the hour and a half since first I had found them there. Furthermore they settled promptly to perfect quietude again, so that only a few minutes later I removed a whole plant with one vigorous stroke of the knife and carried it some distance without perceptibly disturbing them.

One month later, September 24, one lone male *Elis* was found sleeping at 6 p. m. in the head of a white snakeroot. This one, the belated straggler of the season, was the only one I ever saw sleeping in solitude. It was the last seen that year; neither have I been able to find them earlier in the season than June 16.

Thus it is clear that this gregarious sleeping institution is not a thing merely of local origin but one deeply ingrained in the species. Yet in spite of these observations on so many hundreds of the wasps, we have no light upon the question of why the males congregate thus and where and how the females sleep.

Priononyx atratum Lept. [S. A. Rohwer].

One side of the road was lined with clumps of *Erigeron canadensis*. These tall, slender plants were at this stage of their growth about five feet tall. They seemed to be the dormitory of the wasps of this species which worked in a near-by corn-field.

At 5:30 o'clock on the morning of August 13, I found six wasps sleeping very close together at a point about three inches from the apex of one plant. The other stalks harbored no insects at all although they grew very close together in this one clump. I mention this to show that they could as easily have

chosen plants of the same species and equal desirability very near for independent sleeping quarters if they had been so inclined.

In another clump of the same plant a short distance away, three wasps were asleep in the same huddled condition, and on the identical part of one plant, clinging to the stems with the legs instead of the mandibles, as do some other species of wasps. On another scattered group of *Erigeron* not far away, four of these insects were asleep on the tops of four distinct stalks.

At the same hour of the morning three days later I examined a patch of Erigeron in another location and found that the wasps rested in the same manner very near to the top of the plants. Five of these plants harbored one each, and five others bore from two to eight. In every case they were crowded together near the top. The sex was ascertained for 24 of the last lot; they were exactly equal, 12 males and 12 females. Early in the evening they were alert and easily alarmed, but by ten o'clock they could be approached with a strong light, or the stalk upon which they rested could be stirred without arousing any response in the wasps. Even the strong light and warmth from the carbide lamp held for several minutes within five inches of them did not arouse them or delude them with the idea that daylight had come.

Records of about fifty other individuals of this species, at different times and places, show conduct as varied as this; about half of them slept alone, near the head of ironweed, white snakeroot and similar weeds, while the others spent the night in groups of from two to eight, or in one case as many as sixteen. Thus the gregarious tendency is sometimes, although not always, present. In only one instance am I positive that a certain individual came back a second night to sleep on its own particular twig, but the habit of returning night after night each to its chosen spot may be common among them. It would be of interest to ascertain whether this is a fixed habit among them, or only a trait appearing occasionally, a habit developing or declining.

I could ascertain no conditions deciding the question of whether they would sleep singly or in the company of others. Both sexes were present, but I have never observed mating in these night assemblies; the only instance of mating that I have witnessed in this species occurred during the day. I do not see

how safety would be increased by either their aggregation or isolation; if the insects' color and weapon prove sufficient protection for it through its solitary life by day while its enemies are alert, I do not see why it should need further provision for protection at night. Hence the question of the cause or purpose of this imperfect gregariousness still remains open, and even more important than this is the problem again of whether this tendency is ascendant or declining. We may have here the opportunity for a study of the rise of instincts; if so, it will be worth long observation and careful treatment.

Prionony x thomæ Fabr. [S. A. Rohwer].

June 8, 1915, this wasp was asleep on the top of a weed about four feet high on a northern slope of a hill. After being handled rather roughly it eventually roused itself enough to walk when prodded, feebly dragging one foot after the other, but it could not summon enough energy to resume normal activity.

Another was found July 22, at 7:15 p. m. on the top of a dried plant on a hilltop, and a third was clinging to a sweet-clover stalk on a gloomy September evening.

Chlorion (Protosphex) **ichneumonidæ** [S. A. Rohwer].

One July evening at 7:35 when it was almost dark I came upon a sand-wasp at rest, apparently ready to retire for the night. It sometimes turned its body languidly about and occasionally cleaned its face and antennæ, and once it cleaned its wings by thrusting its abdomen above them and rubbing them down.

Two months later, on a gloomy September morning at 8 o'clock, a female sand-wasp was found still asleep on a stink-weed, rather inconspicuous among the fine-cut foliage.

Bembex nubilipennis Cress. [S. A. Rohwer].

These wasps who work so intensely at digging their holes in the earth during the day find shelter in the same hole at night, at least the females do; we have never been able to locate the males' whereabouts at night. It seems the wasp uses her hole in whatever condition it may be, finished or unfinished. At the approach of twilight she creeps into her burrow and from inside she throws up a loose mound of earth to cover the opening. In the morning, when the sun is high enough to begin to

warm the earth, she may be seen scrambling and wriggling out through this loose dirt; if perchance a shower has packed it during the night she emerges looking not a little dishevelled and excited from her exercise butting down her door.

We have opened the nests at twilight and found the mother sometimes in a hole only begun, sometimes almost finished, and at other times already occupied by the larva and its food.

One hole has continued to arouse our curiosity. We had watched it for over a week, waiting for its permanent sealing. Finally at twilight one evening, in company with Mr. E. A. Schwarz, we broke open its temporary closure, and to our amazement found six Bembex in the hole to spend the night. In my astonishment I let four escape, but the other two were females. I can hardly think this nest was for sleeping quarters exclusively, for we have never found another like it, and only the day before I had seen a female enter and depart several times as if it were a normal domicile. Is it possible that this may be an example of the beginning of the gregarious or social habit of wasps?

Philanthus sp. [S. A. Rohwer].

In a Kansas wheatfield on August 14, at 6:30 in the evening, a *Philanthus* was found very artfully concealed among the long beards of a head of wheat which had been missed by the harvester and had by this time turned dark grayish-brown.

Astata pygidialis Fox [S. A. Rohwer].

At the end of a dreary August day we found an open hole in our wasp-field which had not been there that morning. There was a little mound of earth outside, but no pretense of closing the hole. It ran down diagonally for about an inch and a half, and snug inside was the owner, *A. pygidialis*. It remains a mystery where this little proprietress spends her nights when her burrow is finished and sealed, or when she has no hole at all.

Rynchium dorsale Fabr. [S. A. Rohwer].

On a July evening just before twilight I found the hole of a *R. dorsale*, with its occupant therein ready for the night. I removed it with the forceps but when I tried to tuck it back in its nest it flew away.

It was deep twilight a few evenings later when we opened the hole of another and found the owner snug in its burrow, resting as calmly as though it were not expecting intruders at such an hour.

Odyneris firmus Cress. [S. A. Rohwer.]
Odyneris geminus Cress. [S. A. Rohwer]
Odyneris sp. [S. A. Rohwer].

The individuals of these species show marked variations in their habits of sleep, sufficient to lead one to suspect that they curl up and sleep wherever it is convenient at the moment of twilight. We have found *O. firmus* sleeping in its burrow and on vegetation; one was curled around a leaf of Erigeron, and another was in the seed-cluster of a pigweed, in such deep sleep that it unresistingly allowed itself to be picked up repeatedly. *O. geminus* was found in September, clinging to the Melolotus stalks, and a turret-building Eumenid was sleeping in her finished burrow, beside her egg and its first caterpillar.

Vespula germanica Fabr. [S. A. Rohwer].

At 6:10 a. m., on August 18, this Vespa was just beginning to wake up and stretch itself under a green curled leaf of Hibiscus.

Polistes.

When one comes upon a paper nest of Polistes at night he finds the inhabitants quietly at rest, their bodies and legs spread flat against the surface of the nest. I believe they are fully asleep; one may hold a strong light near them for several minutes before they show the slightest response.

Despite the fact that the nests are filled with sleeping wasps, one occasionally finds solitary stragglers asleep among the vegetation. They are often seen foraging or getting nectar when it is almost dark, and it is probable that these are overtaken by night while away from home. During the summer probably twenty individuals in all were seen asleep on the flowers of snakeroot, ragweed and sweet clover. The species were *P. pallipes, rubrigenosus, aurifer, annularis, variatus* and probably *bellicosus*. They are up and busy early in the morning; a *P. aurifer* came to a pond for water at 6:15 one August morning, and a *P. pallipes* was flying from plant to plant at 6:30.

HORN-TAILS.

Tremex columbia Linn. [S. A. Rohwer].

On a number of evenings from July to October, I noticed these horn-tails nervously flying about my mulberry bushes, and finally as twilight fell, selecting a roosting place on the under side of a leaf, and always among the lower branches. Whenever I noticed them during the night or early the next morning, I always found them in the same position.

On the evening of October 2, one, after buzzing about for a few seconds, alighted on the under side of a low leaf of a sycamore tree, and there she remained, sleeping until dawn. An examination by candle-light at 10:30 found her unchanged.

While this horn-tail was buzzing about seeking a leaf among the lower boughs under which to sleep, the upper branches of the old sycamore were filled with uproarous sparrows but she feared them not and sought her place and went to sleep, while a little later the sparrows did the same. This circumstance at once suggested an explanation of the usual peculiar choice of this insect. The under side of the leaf, which was invariably chosen, would afford protection from the view of birds, but this only among the lower twigs, which likewise were always selected. It is obvious that a species which followed an instinct or habit of sleeping on the upper side of leaves, or even on the under side of leaves among the topmost boughs, would rapidly be eliminated by the bird population.

BEES.

Melissodes obliqua Say. [J. C. Crawford].

In an open field which sloped toward the River des Peres, St. Louis, was a burnt area about ten feet square. The grass was burned off, but the charred stalks of weeds two or three feet tall were still standing.

When walking along a path through this plot at 6:15 in the evening of July 19, we disturbed a number of bees. They buzzed about the plants, waiting for us to go on, excepting perhaps a half dozen which remained undisturbed. Two of these were huddled together on one dead leaf, so frail and dry that we wondered that it did not break down with their weight.

An examination of the surrounding vegetation revealed no others, although the swarm was buzzing impatiently about awaiting a quiet chance to alight. So we left the spot and returned an hour later. Now we found the 28 bees clustered near the tops of a small clump of stalks. Since it was now almost dark, my presence did not disturb them. They were huddled together in groups of 2 to 5, with only 3 insects occupying their sites singly. They were settled for the night in their characteristic posture, resting on their support with the head downward, the abdomen ventrally curved as far as their chubby forms would permit.

It is hard to refrain from calling this a case of protective environment rationally chosen by the insect. I surely would not have seen their brown bodies blending with the dingy burned leaves, had I not known just where to look for them. In another field about a quarter of a mile distant the sweet clover was abundant, but a careful search revealed no bees.

The next evening 29 bees, only one more, were asleep on these five stems, all clustered on the apical three inches of the dead plants. On the top of another plant ten feet away, 2 were at rest. All were in the same characteristic position. If they had chosen this site for protection alone they would have rested singly on the plants, but since they huddled in groups, they must have sought sociability also. They were so close together in some cases as to arouse my suspicion about their mating, but a close examination proved the idea false.

The following night, July 21, 24 of these bees were here to spend the night in the same way. On the 22nd, 30 were present. On this evening I marked part of them with white paint in order to make sure whether this uniform group was made up of the same individuals night after night. As fate would have it, by the next evening a cow had broken down their chosen stems, so none of the bees were there. However, 15 were found on similar weeds near by; 7 of these bore the white markings. This gave evidence sufficient to prove that the same bees return to their chosen spot regularly. Part of these were taken to see whether one or both sexes were thus gregarious; of the 18 taken, all were males. They made no attempt to move when picked up with the forceps, while earlier in the evening they could not be approached without a heavy buzzing and flying about.

For some reason the group dwindled from this time on, and each night a smaller number came back; perhaps the disturbance of the cow's intrusion drove part of them away. Up to the end of July from 2 to 4 were usually found asleep at night; these faithful ones were always on the same twigs near the original roost.

A second burned area was found some three hundred feet away, similar in all respects to the first and surrounded by green vegetation. Around the periphery of this burned patch no bees were found, but in the center, on a cluster of five brown stems, 14 bees were at rest. Most of them were huddled together in groups of 2 to 7. All were at rest on or near the tops of the plants, head downward, with the characteristic ventral curl of the abdomen. Here again the bees had chosen this dull spot which so delicately suited their coloration, and away from the edge of the patch. In the early twilight many of the bees were busy cleaning their necks, eyes and antennæ with their front feet. No others were found anywhere in the vicinity.

This group of bees, about 14 to 16 in number, also came repeatedly until the end of July, when the group dwindled and suddenly and mysteriously disappeared. By marking the insects we assured ourselves that the same individuals came back night after night.

In the centre of a thick clump of white snakeroot almost ready to bloom was a dried stalk of the same plant from last year. Crowded together upon the head of this one dead plant were 40 of these bees. All were head downward, in precisely the same position as described before, and were quiet excepting for movements of the legs when cleaning themselves or kicking their neighbors. They were thus settled for the night although the sun was still well up at 6 o'clock on an early August evening. Here is another case of bees selecting dried plants of their own color.

Alongside the green plants bearing *Prionony x atratum* mentioned before was a dried stem; this too was the chosen resting place of 4 of these bees, although green plants were much more abundant all about.

On August 4, 19 bees were still at rest on some bushes at 8 a. m., when the whistle of a passing train caused some of them to fly away. It must have been about their normal hour of rising, for within the next three minutes all the others departed singly for their days work.

A considerable number of other observations in St. Louis and eastern Kansas find these insects usually coming together in groups of 2 to 50 to sleep, although occasionally solitary individuals are found. In almost every case a dead dark colored weed was sought out and given the preference over the surrounding green vegetation. None have been seen in the vicinity of St. Louis later than about the middle of August, although they have been sought.

In one case a single bee was found repeatedly snuggling in the heart of a large group of *Prionony x atratum*. It came here regularly with the wasps before 5:30 p. m.

When the bees were at rest one could see some of them completely covered with yellow pollen. Since about twenty were taken in this condition from sunflowers I take this to be sunflower pollen. Others were dusted with whitish powder, probably snakeroot pollen. One evening I was intensely interested in watching one insect caressing the abdomen of a neighbor with her own. I expected to witness an actual courtship and copulation, but it soon proved that she was only cleaning the pollen off her own body on to her neighbor. They frequently cleaned themselves before going to sleep.

The problem of the purpose or cause of some of the insects coming together thus to sleep remains an open question. So far as we can see they could sleep as well on the individual flowers upon which they feed or near their places of nidification. Their persistent choice of the dull, dead plants strongly suggests an element of protection in this selection. Besides the fact that this dull color is in harmony with their own, it may be that their enemies would be less likely to seek for prey upon old dead vegetation than among the green plants which usually harbor insects. But it does seem that the selection of these dark, dried twigs is a conscious choice.

Melissodes argilis Cress. [J. C. Crawford].

This species of long antennæ bee we observed both at St. Louis and Lake View, Kansas. They hied them to the sunflowers at twilight and almost always squatted flat in the disk, usually one in each flower. They did not hold on with the mandibles, but I think they slightly buried their tarsi in the florets. They seemed to be heavy sleepers and seldom awoke when handled or when the light was flashed upon them.

In one instance, on September 2, the stem and flower containing a sleeping bee were rudely jerked off, carried about a quarter of a mile rather roughly and placed in a cage. The next morning the bee was still asleep in exactly the same position, evidently having not moved during the night.

In all, ten bees were observed in the two remote localities. In every case they chose the sunflower and they always spread themselves flat so that their abdomens touched the florets. By thus sleeping beside their work they were ready to resume their tasks bright and early the next morning. I have seen them at 5:45 on an August morning flying from flower to flower already laden with yellow pollen.

Melissodes obscura Say. [J. C. Crawford].
Melissodes bimaculata Lep. [J. C. Crawford].
Melissodes verroniana Robt. [J. C. Crawford.]

On some dead dock plants standing amid green vegetation on a hill-top were three little bees huddled close together around the stem. All three were of different species, one *M. obscura*, one *M. verroniana*, and the third escaped without identification. On a similar plant, similarly situated a few feet distant, was another group of three curled around the stem in the same manner; two were *M. obscura* and the third was a distinct black bee, *M. bimaculata*. I should like much to know whether these little bees of this genus are always so select of their company and the nature of their sleeping place.

Apis mellifica Linn. [J. C. Crawford].

On June 9 the sun was getting high by 6 o'clock in the morning. I was walking along Watson Road, St. Louis, when I noticed two worker honey-bees still asleep on a cluster of elderberry flowers. One was picked up with the forceps; it was sufficiently awake to move the legs. The second one moved not at all, even when picked up. Closer inspection revealed a white flower spider, *Runcinia alœtoria* Htz. [N. Banks] clinging to the ventral surface of this bee, which was dead. Here this little protectively colored spider had succeeded in capturing the bee asleep. I think it could hardly have discerned the prey in the dark, but that it probably saw the bee and captured it with the first rays of dawn. Bees are supposed usually to spend the night in the hive, but in all probability these were foraging when darkness overtook them. They probably work both early and

late, for on August 18 six honey-bees were seen in the newly opened flowers of the jimson-weed, while the same week many were to be seen flying from flower to flower covered with green pollen at the early morning hour of 5:45.

Emphor bombiformis Cress. [H. L. Viereck].

Seven individuals of this species came to the elderberry bush in my garden while it was still light; at 9 o'clock they were in such deep sleep that they could easily be marked. Owing to poor light however, the work was awkwardly done, and the next morning two were found disabled. The others never returned.

Triepeolus helicanthe Rob. [J. C. Crawford].
Triepeolus lunatus Say. (J. C. Crawford].
Triepeolus concolor. [J. C. Crawford].
Triepeolus concavus Cress. [J. C. Crawford].

We have discovered no hard and fast rules for the sleep of these little bees, excepting that, like most bees, they faithfully keep regular hours, from about 6:30 p. m. until the sun is well up in the morning, and that they habitually choose a leaf or twig of a weed about two feet above the ground as their resting place, although the vegetation was of various heights from two to six feet.

The specimens of *T. concolor* which we have seen were simply sleeping on stems in the position they assume during the day. Our three individuals of *T. concavus* followed each his own fancy in settling to rest; one was curled around a stem, another tightly clasped a leaf of Erigeron with its mandibles while its legs were free and the body horizontal, and the third assumed a comical position, just hanging over a little stem by its middle like a small boy hanging over a rail fence on his stomach.

The little *T. lunatus* were found still in deep sleep at 6:35 on an August morning. They were sitting in an easy, natural attitude, each on the top of an Erigeron leaf, and they were so helpless at this hour that when brushed off they fell down as if dead.

We have observed *T. helicanthe* upon only two occasions. They were grouped in small colonies of three and five. In every case they clung to a little stem by the mandibles while the feet rested lightly upon the vegetation and the body rested head downward.

Calliopsis nebraskensis Cwfd. [J. C. Crawford].

On August 7, when it was nearly dark, I opened a nest of this little bee. She was near the top and I suspect she was still at work for some of the loose soil on top of the mound at the mouth of the burrow seemed quite fresh.

Chrysis perpulchra Cress. [S. A. Rohwer].

These beautiful green cuckoo-bees are very conspicuous near the top of the Erigeron at about the height of a man's shoulder or eye, where they settle to rest in the late afternoon. As long as the daylight lasts, however, when they may still be seen, they are too alert to be in any danger of being captured; only when covered by darkness are they helpless. They usually wrap their tiny bodies horizontally about the small vertical stem or petiole of the leaves or flowers. They probably return to the same sleeping quarters night after night, for I found them on the same clump of plants on three successive nights.

FLIES

Proctacanthus milberti Macq. [F. Knab].

Robber flies have a most tantalizing way of evading capture; as one draws near them they remain alluringly motionless until one brings down the stroke intended for their capture; at that instant they fly away with a loud buzz only a short distance and alight again to tempt one and repeat the performance. In the evening they behave in much the same way when approached until twilight is far advanced, when they relax into deep sleep at about 8 o'clock, resting on the vegetation at a height of about three feet from the ground, and may be picked up with perfect ease. Their night position is not different from that of the day, but the feet automatically grip the support firmly. Whenever taken, whether awake or asleep, they always exude from the anus a drop of brown, pasty substance; I do not know whether this is the normal function of excretion or some special means of protection to ward off the attacks of enemies.

A pair of these robber-flies in copula were watched at Lake View, Kansas, August 18, at 7 o'clock in the evening. These two followed the same tactics of resting and flying for short distances when pursued.

Sparnopolius brevirostris Macq. [F. Knab].

Near a dozen yellow velvety bee-flies were seen at twilight early in September, gracefully resting on various flowers and leaves, but not one could be caught, even by extreme effort, so quick and agile were they.

While I feel confident that they spend the night in the position in which one finds them at dusk and they eventually relax in sleep thus, yet they are more active and alert throughout the twilight period than any other insect I have met among the higher, swiftly-moving insects. Only late in the season, when the weather grew chill, could they be taken at the twilight hours when most other insects could easily be picked up. They do not congregate in definite swarms to sleep, but frequently a half dozen or so are seen occupying neighboring ragweed or other plants.

Argyromoeba obsoletum Loew. [F. Knab].

On July 29, two of these bee-flies were seen asleep, one on the under side of an overhanging rock by the Meramec River, and the other on a twig sheltered by a protruding rock by the roadside. It was quite dark and both must surely have been asleep, for neither my bright light nor my hand when I picked them up disturbed them, although they are normally very active Diptera.

DRAGON-FLIES.

Libellula pulchella Drury. [R. P. Currie].
Libellula luctuosa Burm. [R. P. Currie].
Anax junius Drury. [R. P. Currie].

Dragon-flies are swift and agile in their flight and are difficult to apprehend during the day, at least those species which are abundant in this vicinity. The sharp contrast between this and their behavior after dusk leaves little doubt that they lapse into deep sleep at night. I have noticed only a few individuals at night, but all of these had chosen for their roost a gray, dead twig among green shrubbery, about five feet from the ground. They rest with the head up, holding on with their feet and automatically clinging tenaceously. After they are soundly asleep, at 7 or 8 o'clock, they are indifferent to a strong light or even to being pulled off their support and handled.

ORTHOPTERA.

Dissosteira carolina Linn. [A. N. Caudell].

These grasshoppers are very numerous in the open fields or in the short grass at twilight, but one may beat the bushes and weeds in vain for them. They are protectively colored for their life on the ground by day, and they continue to make use of the same protection for sleep at night, resting on the gray earth or grass of open spaces.

Hippiscus rugosus Scud. [A. N. Caudell].

This fancy hopper is usually a long jumper, but at 6:30 on a September evening this one made two short flights when I attempted to take him, and refusing to move further he was bottled.

Arphia corinata Scud. [A. N. Caudell].

This grasshopper seemed to sleep more soundly than most of its brothers. One which was found on July 29, on the under side of an overhanging rock was not awakened by either my strong light nor my fingers' grasp.

Melanoplus femur-rubrum DeG. [A. N. Caudell].
Melanoplus atlantis Riley. [A. N. Caudell].
Melanoplus differentialis Thom. [A. N. Caudell].

These hoppers, like the others, seem to sleep at night right where they live by day. They are usually found at night or in the early morning clinging, head up, to the stems of stalky plants, such as Erigeron, horse-weed, corn, etc. Sometimes they are alert enough to escape when touched, but they are usually languid, especially in the morning.

Dichromorphia viridis Scud. [A. N. Caudell].

Only two observations were made upon this short-horned grasshopper, at 9:20 p. m. on June 10, at St. Louis. One insect was to all appearances asleep on a grape leaf and the other was actually feeding upon a leaf of poison-ivy, *Rhus toxycodendron*.

Stagmomantis carolina Linn.

Just how or when the devil's horses get their sleep I have never been able to discover, although I have kept many of them under close observation. The males are frequently to be seen

at the lights, and the females in cages are able to capture prey in the dark. They also construct their egg cases after dark, and some of them remain in copulo during the night. These activities were observed during the daytime also. It may be possible that they snatch a little nap between activities whenever opportunity offers.

Amblycorypha oblongifolia DeG. [A. N. Caudell].

Perhaps a dozen of these green katy-did nymphs were seen at rest on the poison ivy, which at that time, mid-June, was tender and bore green berries. Five of these were actually eating the *Rhus*. Three others were at rest on pokeberry plants near by.

Orchelimum nigripes Scud. [A. N. Caudell].

This brown and green hopper was found at rest on the vegetation by 8:30 on different evenings in mid-August, but they were probably awake or sleeping only lightly for occasionally they would move slightly, and one which was picked up bit me so severely that I flung it away in astonishment and it escaped.

BUTTERFLIES.

Pieris protodice [H. Schwarz].

A stretch of vacant land in St. Louis about the size of two city blocks bore a good many patches of the white snakeroot, *Eupatorium ageroides* Linn. At the time when these observations were made the plants had gone to seed, and instead of the pure white flowers at the apex of each stalk was a fluffy mass of awned seed ready to be puffed away by the wind. These gray-white, feathery tufts seemed to be the favorite resting place of *P. protodice* for the period from October 6 to 18.

When walking through the field at deep twilight I saw a number of white spots on top of the grayish heads of this plant, very conspicuous indeed. In this one patch of about twenty-five square yards I counted thirteen of these butterflies, but on the other plants near by, such as sweet clover and yellow daisy, none were sleeping.

It was noticeable that they all thus chose the same kind of plant, but more remarkable was the fact that every one of these butterflies rested horizontally on top of the seed mass with the

head toward the south. A soft wind was blowing from that direction, and a south wind in October may have been sufficient stimulus to excite this choice of position.

An inspection of the field on several other days yielded the following data:

October 7, at 5:30 p. m., 26 individuals of *P. protodice* were asleep on three species of plants as follows:

On the seed-mass of white snake-root	17
On the white flowers of *Aster multiflora*	7
On the white flowers of *Melolotus alba*	2

The goldenrod in bloom in abundance near by bore none at all. They all were fast asleep so they could be picked up and replaced on the twig or even on my coat. Two of them clung thus to my coat all the way to my home, a distance of two blocks. These 26 insects rested horizontally on the top of the flower with their heads in the following direction:

South, 15; East, 4; North, 3; West, 4.

The direction of the wind could not be ascertained on this evening; there was very little and it seemed to be variable.

On October 14 at 5:40 p. m. the wind was directly from the south. The butterflies were again at their old haunts and asleep. Of the 34 examined this evening, 28 were resting horizontally on the tops of the white snakeroot, and 3 just below, in a vertical position head upward, and 3 were on the goldenrod in a vertical position. And, it surely cannot be mere coincidence again, every one of the 31 directly faced the south.

In addition there were this evening three yellow butterflies, *Colias eurytheme* and *C. philodice*, on the goldenrod and snakeroot. Two were in the same position in relation to the wind as above, and the one on the goldenrod was in a vertical position with the ventral aspect of the body toward the wind.

The next observations were at the same hour on October 17. The temperature had fallen by this time, and a chill wind was blowing from the southwest. There were only 14 butterflies to be seen, 12 of them resting on the tufts of the snakeroot, and 2 on melolotus, but each and every one of these insects was facing the south.

By October 18 a more pronounced drop in temperature had occurred. A careful search revealed only one butterfly. The wind was from the southeast, and this numbed insect was

facing north. The next day was cold and none were to be found in the field.

The above notes on the position of sleeping *P. protodice* were for only October. We thought that the insects' behavior may have been influenced by the autumn weather, and it seemed desirable to know their sleeping behavior during the entire summer. The notes below give this data for the following year.

A hillside gently sloping toward the north was covered in the early summer with horseweed, wild tansy, ironweed, poison ivy, dock, etc. In the center of this variety of vegetation was a patch, about fifteen feet across, of the white milkweed in flower. On these plants at about 5:30 p. m. were hundreds of these white butterflies feeding, flying about, and a few pairs mating. "What an opportunity," thought I, "to return at twilight and see how the insects orient themselves in reference to wind, light, etc., when preparing to sleep, with sufficient numbers in a limited area to make the data conclusive."

At 7:25 I returned to this spot, but where I looked for hundreds to be asleep on the plants upon which an hour before they had been so exuberantly drinking in all the goodness of life, I found but two fluttering from flower to flower, sipping here and there, and soon these too disappeared. They had left off their gregarious habit of the day and each one had individually sought his own resting place for the night. A few of them were found on near-by bushes, iron-weed, horse-weed and low grass, but these were only a small part of the splendid flock; most of them had flown to some distant place. The nearest butterfly was ten feet from the food-plant, and not one rested on the milkweed.

Since so few were in the immediate vicinity, they never occurred more than one on each plant, and they all rested in a vertical position, with head up. In the question of their relation to the wind we have two points of environment to consider: some of the butterflies rested on low plants and grass in places protected from the wind, and others rested on or near the tops of tall plants, in places exposed to the wind. A gentle breeze was blowing from the east at this time; when we examined the butterflies at rest on the high plants in the full sweep of the wind we found them with the ventral side of the body facing:

East, 22; North, 1; West, 0; South, 1.
Northeast, 3; Southeast. 1; Northwest, 2; Southwest, 0.

This shows that not one was holding its position with its wings against the wind, but that 26 out of 30 were facing entirely or partly toward the east, so the wind could not force their wings open.

Of those in the sheltered places in the low grass we have a smaller number, and in the following positions:

East, 1; North, 5; West, 1; South, 0.
Northeast, 0; Southeast, 1; Northwest, 0; Southwest, 0.

Here in the sheltered spots we find 5 out of 8 facing northward. We could find no reason for this condition unless the moving air was deflected from its course there among the lower vegetation.

If the sleeping butterflies were disturbed early in the evening they would fly to another plant; if disturbed later, just about dark, they would drop helplessly to the ground or a lower leaf and remain there. We routed twelve sleeping butterflies in the early twilight to see in which direction they would fly in choosing their new location. Every one of them flew westward, with the wind. Three of them at first fluttered faintly toward the east, but in a moment they righted themselves and floated westward.

Similar observations at twilight on June 16, when an east wind was blowing showed 39 out of 45 facing windward.

On August 26, about 90 sleeping *P. protodice* were counted, mostly upon the ragweed. The vegetation upon the field was stunted and low, and the wind had a clear, open sweep across it. The wind was from the east, and all but eight of these had their heads or bodies accordingly facing eastward.

On September 8 a strong wind was blowing from the southeast. Each and every one of the 55 butterflies in the field was facing toward the wind. Each one of these was picked up and thrown into the air; about half of them floated with the wind and the others went with much force against the wind, but in every case they soon whirled around and followed the wind.

Seven other countings of *Pieris* in different places and times showed the same orientation.

The question remains: do the insects intelligently orient themselves toward the direction of the wind, or does the wind, when they are languid, mechanically swing them around to the position of least resistance? We have not ascertained whether, if the wind should change its direction during the night, it would forcibly turn the butterflies about in their sleep or cause

them to waken and shift their position. The helplessness of the drowsy butterflies when thrown up into the breeze, and the fact that about half of them tried but failed to go against the wind would lead us to conclude that this habitual position is the result merely of mechanical force upon the languid insects.

Minot points out that the allied species, *Colias philodice* and *Pieris rapae*, begin to alight on the grass and before twilight is ended they creep down to the roots of the grass-stalks and there spend the night in sleep. The difference in habits of those and our species may be due to meteorological conditions. Minot's observations were probably made at Boston, where the temperature and the breezes would probably be more trying in unprotected spots than at St. Loius.

Pieris rapæ Linn.

At 8:30 p. m. on August 17 this white butterfly was asleep on a pig-weed, sitting on the top of a leaf.

Nathalis iole, Boisduval [G. T. Hosenfelt].

At dusk during the early days of September hundreds of these little yellow butterflies may be found at rest or asleep on the grass or on the low twigs of weeds. If one walks through the vegetation while it is still light, they fly up in great numbers; if one attempts to take them he will have difficulty in doing so for they fly away without much provocation. But as darkness falls they become lethargic and may be picked up like blossoms.

They show to some extent the same anemotropism as do *P. protodice*; they always creep down to a sheltered twig near the ground, quite ignoring the many taller plants, as iron-weed and snakeroot, which abound near by.

Phyciodes tharos Drury [G. T. Hosenfelt].

We have a number of records of this species, noted during August and September, and each case differs from the others. Two were found asleep at 10 o'clock in a vertical position on the twigs of a dead willow five feet from the ground; another rested horizontally on the low branches of a cocklebur; another was found drowsily feeding at twilight on the disk florets of a sunflower, and still others were on the ground and on the tops of iron-weeds. They became drowsy and sluggish in the early

evening, near 6 o'clock, but they do not fall into deep slumber until 9 or 10 o'clock, but even then they retain enough self-control and vigor to teasingly wriggle away from one when caught.

Pyrameis cordui Linn. [G. T. Hosenfelt].

This butterfly was found asleep just above my head on a cedar tree in Kansas, August 13. It was so languid that it was easily taken with the fingers.

Thecla melinus [G. T. Hosenfelt].

This red spotted butterfly was found asleep at 5:45 a. m., August 18, on the under side of a leaf of horse-weed, three feet from the ground.

Anosia plexippus Linn.

This milkweed butterfly is a rapid flyer during the day. That it actually sleeps at night I have no doubt after having observed a large number of them in eastern Kansas between August 8 and 18. They usually select the apex of some tall plant, like Erigeron, corn or horse-weed, or choose a twig of a tree at the same height, always about six feet from the ground. many are to be seen still on the wing at 6 o'clock in the evening, but by 6:30 they are settling down on their chosen roost for the night, and an hour later they are sleeping so soundly that they are powerless to escape when disturbed. They cling tenaceously to the support in their sleep, and are not aroused by a strong light falling full upon them. Even when handled they show no response, and when dropped, only flutter aimlessly and fall. They are commonly to be seen mating on the wing during the day, but sometimes spend the night in copulo and are very slow to separate when disturbed. They are early risers, and are actively flitting about long before most other insects. On three different mornings in August, many were to be seen flying about at 5:30 and 5:45 o'clock.

Argynnis cybele Fab. [G. T. Hosenfelt].

Lake View, Kansas, August 19. At 6:10 p. m. this silver-spotted butterfly was asleep on the under side of a red-haw leaf twelve feet from the ground. After vigorous and prolonged shaking of the bough it awoke and flew away; the next morning at 7 o'clock it or another of the same species was again fast asleep on the identical spot.

Atalopedes huron Edwards [G. T. Hosenfelt].

A good many of these butterflies were at rest on cedar and other trees at 8:30 p. m. and still the following morning at 6 a. m. At both times they would promptly fly away when touched, but they did not appear in the least disturbed by my carbide light. On two nights, August 19 and 20, they behaved in the same manner, so I do not know whether they were sleeping lightly or only resting.

MOTHS.

Hyphantria cunea Drury [G. T. Hosenfelt].

This species seems to sleep, or at least relax for a night's rest, in any spot convenient at the moment and without any regular manner or formality. We have found them resting after 7 or 8 o'clock upon a variety of vegetation—grass, sunflowers or weeds. However, they may not confine their rest to the night hours, for we came suddenly upon one which seemed to be asleep in the middle of an afternoon in September.

On September 24 I found seven of this species asleep on various plants in a field on a hill-side. It is interesting to note that every one of the seven rested directly facing the wind.

When picked up at night they often struggle clumsily to free themselves.

Hæmorrhagia tenuis Grote [G. T. Hosenfelt].

Only one specimen of this species has been taken while asleep. At Lake View, Kansas, on August 20, at 8:10 p. m. one was found sleeping on a cedar twig five feet from the ground. Neither the strong light nor my carrying it about on my finger disturbed it in the least or aroused its resistance.

Hæmatopsis grataria Fab. [G. T. Hosenfelt].

On the evening of August 19 many of these small yellow Lepidoptera were on the plants, some in copulo, but they were evidently only resting for they were agile in making their escape when we tried to take them.

Apantesis arge Dru. [G. T. Hosenfelt].

This species was noticed only in the latter part of August and early September. They seemed to go to rest for the night on the ground or on the first convenient stem at hand from six inches to three feet above the ground. Sometimes several occurred near to each other, but seldom more than one on a stem. At that time of year they usually rested, head up, on dead or dried stems.

Utetheisa bella Linn. [G. T. Hosenfelt].

This red mottled moth shows the same behavior night and day; when picked up it slowly opens its wings and so remains motionless.

BEETLES

Diabrotica 12-punctata.

Like the striped pumpkin beetle, these spotted cucumber beetles apparently behave at night very nearly the same as during the day. The two insects are often associated together; where you find one you have not far to seek for the other.

On June 10 at 9:30 p. m. several were at rest on the blossoms of the elderberry. I could not discern whether or not they were asleep. At the same hour on August 30 they certainly were wide awake, walking about on sunflowers and feeding on the petals. On August 15 at the same hour and at 6 o'clock the next morning they were in the flowers of the jimson-weed. When the cucumber blossoms were examined at 5:50 a. m. none were found in the newly opened blossoms, but in the old flowers of the day before which had already closed there were several of these spotted beetles. This shows that at least they are not active enough at that hour to migrate speedily.

On September 14 at 8:30 p. m. two spotted beetles were to all appearances asleep on the radial florets of a sunflower, but when the carbide light was thrown on them they gave a slight response in the form of movement of the antennæ.

From these observations I assume that this species has no regular hours or conditions to sleep.

Diabrotica vittata Fab.

I hardly think that these striped pumpkin beetles sleep during the night; at least many of them were active in the jimson blossom at 9:30 p. m. on August 15 at Lake View, Kansas. The next morning at 6 o'clock many of them were still in the blossoms, but I can offer no guarantee that they were the same individuals. Again at 5:50 a. m. on August 16 and 17 I found from two to seven individuals of this species in each of twenty pumpkin blossoms. Many of them were in copulo. Since these flowers do not open until early morning, this is evidence that they must have been awake and migrated during the night.

Copris carolina Linn.

Just after dark July 29, we followed the sound of a heavy, buzzing insect and turned our light upon a flying *Copris carolina*. It was hovering in the road above a pile of fresh horse-dung.

Canthon lævis [E. A. Schwarz].

This dung roller was often seen during the day buried under soft dung; sometimes it was abroad at night, up to 11:30 p. m., rolling and burying its ball. The periods of rest are very irregular, but since the animal goes into the burrow with its food ball and sits at table until all is eaten, perhaps sufficient periods of rest occur at these times.

Harpalus ruficornis [E. A. Schwarz].
Harpalus pennsylvanicus [E. A. Schwarz].
Harpalus caliginosus [E. A. Schwarz].

One can scarcely stroll out over a pasture field on a summer evening after dark without being greeted by these active beetles on the wing or ambling along the path or scrambling through the grass. But on a cold, damp September evening we have found *H. ruficornis* in their holes. Perhaps they all sleep in their holes at one time or another, just as it suits their convenience.

Limonius agonus Say. [E. A. Schwarz].

June 10, at 10 p. m. two of the small brown click beetles so common here at St. Louis were calmly at rest on a leaf of poison ivy. I could not discern whether they were asleep.

Lachnosterna.

Several of these may-beetles were found, when the light was flashed upon them, to be feeding on the leaves of the elderberry and grape on early June evenings between the hours of 9 and 10 o'clock, an hour when all honest insects are abed. We know they are abroad even later than this by the thousands which come to the lights.

Nemognatha lutea [E. A. Schwarz].

These yellow sunflower beetles inhabit the blossoms of sunflowers during the day, occasionally flying from one disk to another. They do not drop to the ground, as do some insects when disturbed, but they feign death for a short time by stretching out and stiffening the legs. They spend the night in the sunflowers in the same way, and if they really sleep one cannot discern it; the head and mouth-parts are usually covered with pollen, and the head is often buried in the flower, as are also the legs. When disturbed at night they feign death in precisely the same manner as during the day; from this I conclude that they are not really asleep, but perhaps only resting in the midst of their food supply.

Chauliognathus pennsylvanicus [E. A. Schwarz].

These beetles which are so common where flowers abound seem to sleep right in their day-time quarters, on the disks of sunflowers or daisies, or on the clusters of elderberry or white snakeroot flowers, etc. We have found them in great numbers, both singly and in copulo, resting on these flowers at night, from midsummer to autumn.

Epicauta pennsylvanica DeG. [E. A. Schwarz].

At dusk on August 7 about fifty small black blister beetles were clustered in the crannies of the inflorescences of a group of six goldenrods; none occupied positions on the plant below the flower-heads. They were apparently ready to spend the night, and many were readily taken. They did not drop to the ground upon slight disturbance as usual during the day, and one had to poke them persistently with a pencil to induce them to fall, but they did not cling so tenaceously to the plant as did

their larger cousins. This may be due to the fact that the larger ones were visited later in the evening when they were more sleepy.

As late as September 11, on a cold damp morning a few of these beetles were still to be seen asleep on the goldenrod. Even later in the season, September 28, a few were still occupying the goldenrod, a number of them in copulo.

Macrobasis longicollis Lec. [E. A. Schwarz].

The larger blister beetle is a very agile, sensitive creature. They have the habit, developed to a remarkable degree, of dropping from their plant to the ground immediately upon the approach of the least provocation. In fact this dropping reaction is so pronounced in the blister beetles that when taking them we customarily place the cyanide bottle beneath them and merely touch them to cause them to tumble in.

On July 24 I found eight of these asleep on the iron weed. They showed no consciousness of the light, and did not respond to the disturbance by falling as usual. Here at night we found that they could be tapped repeatedly with a pencil and their only reaction was to walk a little distance and rest again—perhaps sleeping, we could not tell, sometimes on a stem and sometimes on the under side of a leaf. When the insect was forcibly thrown to the ground it would not feign death as usual but would immediately creep up the nearest stem and rest. This sometimes happened to be only a short blade of grass; in that case the insect would climb to the top of that but immediately come down when it found its altitude insufficient, try several others perhaps with the same result, until it would finally find a tall weed up which it would scramble in apparent glee, perfectly happy when it had reached the top. The insects sleep upon their food plants and have an aversion to spending the night on low plants or upon the earth.

A typical case of the behavior of an individual under experimentation is the following:

I awakened a beetle by hitting it hard with a pencil six times; it walked slowly to another leaf without the expected dropping. I pushed it from its support and forced it to fall to the earth; it immediately climbed to the top of its weed again.

Another beetle was at rest six inches from the apex of its food plant. I gave it twenty raps with the pencil when, instead

of dropping, it crawled to the apex of the plant. When I left it in peace again it crept down to its own chosen spot on the plant. I then gave it six more hard licks, whereupon it sought shelter under a leaf near by. With sixteen more blows the insect walked to the under side of another leaf, and even with twenty more hard licks it could not be induced to perform the daylight drop. Becoming impatient, I carried the insect bodily to a nearby path. It walked about eighteen inches to a small plot of short grass, climbed to the top of one blade and tried to look out, and at once meekly came down and tried another. I took it up and carried it to an iron weed near by. Here it plodded its way faithfully to the top where it wearily settled itself. By this time my curiosity was fully aroused as to how much the beetle would endure without fully waking, but at this point the urchin who was holding the lantern exclaimed: "Aw! pick on somebody your own size!"

CONCLUDING REMARKS.

Scudder in 1889, in speaking of the butterflies at rest and asleep, says: "Up to the present time no proper investigation has been made in regard to the sleep of insects. A wide and open field lies before the enquirer, and it is for his use that I have tried to bring together a few facts concerning the postures and behavior of butterflies in different circumstances. The facts however are too few whereon to base any general statements likely to require no important modification on future investigations, and I leave them for the present barren of results in the hope of enticing some one to enter a promising field and perchance relieve these facts of their present stupidity."

Despite these suggestive remarks, twenty-six years have elapsed without an investigator making a study of the ecology of sleeping insects solely. But here and there are recorded or more often buried under some far-away title some casual notes on the sleeping habits of insects.

The foremost among these are on the most interesting insects from a psychological point of view, the Aculeate Hymenoptera, bees and wasps. Peckhams tell us that the wasp *Astata bicolor*, when she turns in for the night, closes the door behind her until 7:30 o'clock the next morning; then she finishes, fills and seals this nest and begins another which by evening is

far enough along to furnish her good shelter for the night, and so on she always plans and executes her day's work so that each evening she has her lodging-place ready for the night.

They also noted that the male *Philanthus punctatus*, which is without a sting and does not assist in nest building, excavates for himself holes to shelter him for the night, covers the opening with loose soil, and returns to the same abode for several nights. They also mention *Pompilus scelestus* hanging to a leaf of a plant four inches from her burrow and there falling asleep until after eight the next morning, and the wonderful industry of *Crabro stirpicola* working at nest-building for forty-two consecutive hours with only a ten minute interruption.

Hartman finds that a day's work of *Odynerus dorsalis* consists of storing a cell, closing it and building another to be used as a sleeping apartment for the night.

Fabre records finding on a mountain some hundreds of *Ammophila hirsuta* assembled under the shelter of a stone. He has speculated much in attempting to account for this gregarious condition of solitary wasps, but in view of the fact that we have recorded similar phenomena in the sleep of *Ammophila pictipennis*, *Chalybion cæruleum* and *Elis 6-cincta*, we cannot interpret his observations other than that the wasps had come together for the purpose of sleep.

These mentions will indicate that the subject is pregnant with possibilities from an ecological point of view, and probably more so from a physiological view-point. The sleep of an organism signifies more than a mere pause in its activity while darkness covers it; while we have not in the present paper touched upon the physiological phenomena of their sleep, we have found many interesting associations of this with the other activities of the insects. For instance, it is of marked biological interest that a few species certainly seem to choose protectively colored situations, and others select sites which are in various ways protective; that some which are solitary by day are gregarious at night, that some insects sleep with all the regularity of a theoretical modern infant, while others of a more unsystematic life snatch a wink when they can. We do not know whether the anemotropism evident in the behavior of some insects is a physiological or psychological phenomenon, or merely mechanical in its origin.

There are many other larger problems that should emanate from a study of sleep, such as the effect of regular or irregular sleep on longevity, the correlation of food habits with the sleeping habits of insects (vegetable feeders more frequently regular sleepers, while carnivorous species are irregular); the correlation of sleep and hibernation, the physiological differences and similarities; the habits of rest of animals in the higher or lower planes of evolution, or the correlation of sleep with the degree of nervous development (*e. g.*, the wasp must provide its own food, build the nest and provision it—a hard life of high mental exertion—while the Dermestes or the bed-bug has no such tasks; hence is the same rest needed for both?)

The sleep of animals in the immature stages, larval, pupal or even egg stage, is something untouched upon, and observation on the sleep of insects that can be kept in confinement, such as roaches, dermestes, meal-worms, etc., offers to the investigator the comfort of the laboratory for his investigation.

In closing let us again say with Scudder: "Only a few of the most patent of tricks and ways of butterflies [insects] have been noted. * * * These are however still too few whereon to base any general statement, * * * and I leave them in the hope of enticing some one to enter a promising field and perchance relieve these facts of their present stupidity."

ANNOTATED BIBLIOGRAPHY.

Adams, C. C. Bull. St. Lab. Nat. Hist. **11**: 110, 119, 140, 193. 1915. Even Noctuid caterpillars such as *Peridroma saucea* and its allies, which live on the ground during the day, climb trees at night. Mentions sleeping habits as recorded by Banks, Brues and Bradley: *Scepsis, Chlorion atratum, Polistes variatus* and *P. pallipes* sleeping on goldenrod flowers.

Annandale, N. Proc. Roy. Phys. Soc. Edinb. **29**: 439-444. 1900. *fide* Longstaff. He thinks the majority of Malayan Phasmidae are active in the intense heat of midday, when most of their enemies of the jungle are at rest, but remain well concealed in the early morning and late afternoon.

Ashmead, W. H. (Discussion.) Proc. Ent. Soc. Washington **4**: 26. 1896. Noticed wasps in N. Carolina in early morning, but had never seen them asleep.

Banks, N. Sleeping habit of a bee. Ent. News **19**: 340. 1908. A little black bee, *Panurginus illinoiensis* Robt., ♂'s only, have been found asleep; they rest with wings folded close to the body, upon the yellow center of the daisy. They first fell asleep about 6:30 P. M., and by 7:00 many were so soundly asleep that one could frequently pick up a flower containing them and carry it some distance without disturbing them.

Banks, N. Sleeping habits of certain Hymenoptera. Journ. N. Y. Ent. Soc. **10**: 209–214. 1902. Notes on sleeping habits of *Ammophila pictipennis* Walsh, *A. vulgaris* Cress., *Epeolus remigatus*, *A. urnaria* Klug, *Melissodes bimaculata* St. Farg., and *Myzine sexcincta* Fab. ♂'s.
In a field near by a few *Bombus americanorum* were found clinging to the under side of a wild carrot flower, back downward; they did not grasp with their mandibles. *Cerceris kennicotti* was resting under a loose piece of rail. *Halictus lignotus* and *Odynerus conformis* were on grass heads. In New Mexico six *Amegilla smithii* Cress. were asleep, clinging by mandibles to grass stems.

Barrand, ——. Resting Attitudes of Rhopalocera. Entomologist **1906**: 160.

Barth, G. P. Bull. Wisc. Nat. Hist. Soc. **6**: 150. 1908. *Anacrabro ocellatus* Pack. still working at 7:45 P. M.

Bate, D. M. A. Notes on the resting attitude of *Zamacra flabellaria*. Entomologist **36**: 106. 1903. *Fig.* Assumes a peculiar position when at rest, forewings erect above the thorax and at the same time folded like a closed fan. The under wings are also folded, but to a smaller extent and are only slightly raised; the hinder end of the body is also raised. The antennæ lie close along the sides of the body. Quotes Sir George Hampton, Fauna Brit. Ind.: Moths of genus *Gathynia* repose in the form of a cross, with the forewings rolled up at right angles to the body, the hind wings folded close to the body.

Bolle, J., and **M. Richter.** Studien uber die Ursache der Schlafzucht der Seidenrapue. Zeits. Landw. Versuchs Oest. **1903**: 287. Abstract, Zool. Zentralbl. **1903**: 911.

Brischke, G. A. Ent. Monatsber. **1**: 11. *Psammophila viatica* associated in numbers at the end of September; apparently all females. Fact verified by reviewer in Zool. Rec. **13**: 130.

Benton, ——. (Discussion). Proc. Ent. Soc. Washington. **4**: 26. 1896. The honey-bees when asleep hold to each other in a cluster; the upper ones grasp any projection with the mandibles while the lower ones grasp also with the mandibles and forefeet the legs of those above.

Beutel-Reepen. Die Stammengeschichliche Entstehung des Bienenstaates. Einfamillenstaat. Leben and Wesen der Bienen. 45–66. The ♂'s of several species of solitary bees spend the night congregated in large clusters. *fide* Turner.

Biro Lajos. Szabadban alva mehek es darazok. Ravartani Lapok. **2**: 169–172. 1885. Observations on about twenty species of Hymenoptera while asleep upon *Centaurea urenaria*. *fide* Psyche.

Bradley, J. C. Gregarious sleeping habits among aculeate Hymenoptera. Ann. Ent. Soc. Amer. **1**: 127–130. In California, June, 1907, a bunch of black wasps, *Priononyx atrata*, were asleep on dried stems of wild oats, in groups of from 2 to 25; 490 were taken in one hour. A week later they were less abundant. (Naturally when 490 were taken). Also *Prionyx bivelolcatum*, *Sphex* (*Ammophila*) two species, *Monedula emarginata*, *Steniola duplicata*, *Stizus unicinctus* and *Sphecius fervidus*, Cr. Associated with them were bees, *Bombus* sp., *Halictus farinosus* and *Melissodes agilis*. He thinks they had previously been scattered over the large field, but had been driven together thus by the recent cutting of the field.

Brues, C. T. On the Sleeping Habits of Some Aculeate Hymenoptera. Journ. N. Y. Ent. Soc. **11**: 228–230. 1903. *Priononyx atrata* along shores of Lake Michigan at Chicago; large number asleep on a large sweet clover. In McHenry Co., Illinois, several species were commingled upon the same plants, viz.: *Epealus lunatus* a parasitic bee, *Scolia bicincta*, *Nysson plagiatus*, *Tachytes* sp. The Texan *Scolia lecontei* chooses a species of Umbelliferæ as its sleeping-place and rests, head downward, upon or below the umbels of the plant. The common *Myzine sexcincta* rests not only at night but in the middle of the day also. In southern Illinois and also in Massachusetts the ♂'s of this species occur in abundance on the dry plant of the wild pink.

Champion, H. G. and **R. J.** Observations on the life history of *Methoca ichneumonides*, Latr. Ent. Mon. Mag. **50**: 268. 1914. Spends night and dull weather in an empty hole or any dark hollow.

Chapman, T. A. Butterflies at rest. Ent. Rec. **18**: 168–170. 1906.

Cockerell, T. D. A. Ann. & Mag. Nat. Hist. **1900:** 413. Found *Anthidium perpictum* "resting on the stems of grass in dull weather." *Fide* Banks.

Cresson, E. T. Hymenoptera of Cuba. Proc. Ent. Soc. Phila. **1865:** 88. Prof. Poey informs him that *Melissa rufipes* "retires to a bush to sleep, it seizes a branch with its mandibles and places itself in a horizontal position, the back turned toward the ground." *Fide* Banks.

Cresson, E. T. Hymenoptera Texana. Trans. Amer. Ent. Soc. **4:** 201. 1872. Cresson states that Belfrage said that *Scolia lecontei* rests during the night and chilly weather in clusters closely attached to the stems of grass and plants. *Fide* Banks.

Darwin, C. Power of Movement in Plants. Chap. VI and VII. 1896.

Dubois, R. Etude sur la Mecanisme de la Thermogenese et du sommeil chez les Mammiferes. Physiologie comparee de la Marmotte. Ann. Univ. Lyon. pp. 268. *125 pls. 119 figs.* 1896. Not seen.

Eaton, A. E. Aculeate Hymenoptera from Burgos, Old Castile, collected during the total eclipse of the sun, August 30, 1905. Ent. Mag. **42:** 96–98. 1906. *Bombus* and hive bees ceased to be seen, and ants went to sleep on shoots of a yellow-flowered *Ononis*.

Fabre, J. H. The hunting wasps. Tr. by A. T. de Mattos. p. 67, 255. 1915. *Sphex flavipennis* retires into her burrow at night, and also seeks shelter there in bad weather or rests for a few moments during the day. The sandy *Ammophila* and the silvery *Ammophila* do not spend their nights or leisure in their holes, but leave the premises altogether after concealing the entrance with a stone.

Fabre, J. H. The hunting wasps. 1915. Records a single instance of finding on Mont Ventoux, at a height of 6,000 feet, some hundreds of *Ammophila hirsuta* under the shelter of a stone. While Fabre has some difficulty in interpreting this phenomenon, I can only see in it an analogous condition to that recorded for *Ammophila pictipennis* or *Chalybion cæruleum*—viz.: congregating for the purpose of sleeping.

Fabre, J. H. The mason-bees, p. 86. 1914. The mason-bee of the walls, *Chalicodoma muraria* spends the days and nights in one of the cells of her dome, suspended head downwards; the mason-bee of the sheds, *C. sicula*, does very nearly the same as long as there are vacant galleries in her nest, but after these have been used as cells she selects another retreat. The Chalicodomæ pass the nights in the stone heaps in the harmas in numerous companies, piled up promiscuously, both sexes together. The most common dormitory is a narrow crevice between two stones; here they all huddle, lying flat on their backs like people asleep. Should bad weather come on, they do not stir.

Fiebrig, K. Schlafende Insekten. Jenaische Zeits. Naturw. **48:** 315–364. 1912. See appendix.

Fletcher, T. B. Do butterflies migrate by night? Spol. Zeyl. **4:** 178–179. 1907.

Floersheims, ——. Tutt Ent. Rec. **18:** 36–39. 1906. Description of the great extent to which beetles attack and kill sleeping butterflies. (*Fide* footnote Ent. Soc. Lond. p. cxxi. 1906.)

Fountaine, ——. Roosting habits of *Heliconius charitonia*. Entomologist **44:** 403. 1911. They assemble between five and six P. M. and sleep in clusters. One group of a dozen or so noticed every morning always on the same twig of *Phenox hitrus;* sound asleep at six A. M.

Frohawk, F. W. The Sleeping Attitude of Lycaenidæ. Entomologist **47:** 212–213. 1914. It is generally supposed that the Lycænidæ sleep throughout the night sitting head downward on flower heads and grass stems, in the characteristic attitude they assume in the evening, but later when darkness supersedes the twilight the butterflies (*L. icarus*) turn around and sleep head upward. The author and Mr. W. Holland marked and watched groups of these butterflies and found "they were all head downward from 4 P. M. until darkness; in every case they reversed their position to head upwards at dark," which position they retained for the night.

Garner, R. L. (Abstract.) Science **42:** 843. 1915. The African anthropoid apes sleep on their backs like men, and make their beds eighteen or twenty feet above the ground.

Gill, ——. (Discussion). Proc. Ent. Soc. Washington **4:** 26. 1896. Fish when supposedly asleep are simply quiescent with their fins waving at intervals or entirely still. African *Dipnoan protopterous*, when streams dry up, goes into the mud, makes a cocoon of slime surrounded by mud, and in this condition has been carried to Europe and revived by placing it in water and dissolving the cocoon.

Green, E. E. Sleeping Habits of a Bee. Ent. Mon. Mag. **1899:** 214. Not seen.

Hartman, C. Observations on the Habits of Some Solitary Wasps of Texas. Bull. Univ. Tex. No. 65: 7. 1905. A day's work of *Odynerus dorsalis* consisted of storing a cell, closing it and building another before evening to be first used as a lodging place the following night and filled the next day. (Hartman, in a letter, says he suspects this species has been erroneously identified for him.)

Hine, J. S. Techn. Ser. U. S. Dep. Agr. Ent. No. 2, pl. ii, p. 24, 1906. The autumn horse-flies, *Tabanus sulcifrons* Macquart, are most active in the strongest sunlight. As evening approaches they become less active and seek a resting-place among the foliage, on some tree-trunk, or on a fence where they remain quiet until sunrise. They have a tendency to collect at evening in certain favorable places in large numbers, ♂'s and ♀'s together.

Hoffmann, F. Wie und wo nachtigen die Tagfalter? Mitt. Polyxena Wien. **6:** 1. 1911. (Not seen.)

Ingersoll, E. Life of animals. p. 313. Quotes Perry, on the Wapiti deer: "If there is a stream running through the valley, bordered by a sand bar, the entire band makes this their sleeping place, and the band always assume the same position in sleeping—the calves, cows and yearlings in the center, and the bucks around the outer edge of the circle, so that in case of a night attack by wolves or panthers the strongest will meet the first onset of the foe."

Isely, D. The Biology of Some Kansas Eumenidae. Kans. Univ. Sci. Bull. **8:** 243, 299. 1913. Quotes Hartman on *O. dorsalis* in reference to its using each newly constructed cell for a night's shelter. Scolids and Ammophilæ and a solitary *Eumenes bolli* would collect for the night on the tall prairie grass in Ness Co. *Eumenes* did not hold its body rigid as did *Ammophila*, but held itself at right angles to the stem with its abdomen curled under it.

Jensen-Haarup, A. C. Maerkvaerdig Sovestilling hos hannes af visse Bier. Kobenhavn Flora og Fauna 1909: 65–67. A remarkable position during sleep among the males of certain bees. (Not seen.)

Kearton, R. The Fairy-Land of Living Things. Where birds sleep. pp. 58–61. 1908. A popular account.

Kolbe, W. Ueber das Eintreten des Sommerschlafes bei den Chrysomeliden. Zeits. Ent. Breslau **24:** 26–57. 1899. Not seen.

Longstaff, G. B. Some rest-attitudes of butterflies. Trans. Ent. Soc. Lond. **42:** 97–118. 1906. *Lycæna icarus* asleep on the heads of grasses; 12 out of 15 had head down. Most butterflies when asleep usually close their wings over their backs, but some of the larger skippers such as *Caprona* probably sleep with them spread out like geometers. The common skippers *Pamphila sylvanus* and *P. linea* adopt the usual butterfly attitude, but Roland Trimen called attention to the fact that *Nisoniades tages* L. sleeps with the wings inclined so as to form a roof, like many Noctuæ, (Barretts Lepid. Brit. Is. 1: 309.) *G. rapæ* when settled for the night makes no effort to resist capture. *G. brassicæ* goes to sleep on hawkweed, etc., at 7:15 P. M., and remains with wings hanging down and closed over its back.

Martineau, A. H. Entomologist **29:** 268. 1896. *Sapyga clavicornis* when at rest, "lays its big clubbed antennæ between its legs along the under side of its body and quite out of sight, the clubs being turned upwards at the end."

McCook, H. C. Nature's Craftsmen. pp. 64–67. 1907. The toilet operations of ants usually precede and follow sleep. Their sleepy ways may be illustrated by a group of 25 or 30 agricultural ants. They had been lured by a gas lamp upon the table from underground galleries in a glass formicary. They grouped themselves in little clusters next to the light, on top of corks, clods or pebbles placed for them, for they like slight elevations. Most of them cuddled upon the surface, some squatted upon their abdomens, some lay upon their sides, some stood tiptoe on their hind legs, some crouched upon the earth, piled

high one atop the other. There was constant agitation in the clusters, and frequent changes of position. While the ants of one group were sleeping, others would be at work, and these at times would vigorously jostle the sleepers. New members occasionally joined a group and in their eagerness to get close up to the heat, crowded their drowsy comrades aside. Ants at work in the galleries would drop the pellets they carried, push into a group of sleepers and presently be sound asleep themselves. The longest period during which individuals were observed to sleep was three and a half hours.

Minot, C. S. Notes on the Flight of New England Butterflies. Proc. Bost. Soc. Nat. Hist. **14:** 55–56. 1870. The postures of the butterflies by day are all different from those assumed by night. A little before sundown *Colias philodice* Godt. and *Pieris rapæ* Shrank, begin to alight in the grass. "As it gets later they become more and more inactive until finally they will allow themselves to be trodden upon, pinned and handled in any way. Before twilight is ended they creep down, or descend in some manner, I do not know how, to the very roots of the stalks or blades of grass." They always choose a perpendicular stalk, the wings are raised over the back, the outer edges pressed together, the antennæ are kept nearly perpendicular to the axis of the body and almost concealed by the front edges of the wings.

Morley, M. Wasps and Their Ways. p. 120. 1901. Hornets have been known to work by moonlight. Captive wasps are unable to sleep with a light near by.

Noyes, A. A. Biology of the nest-spinning Trichoptera. Ann. Ent. Soc. Amer. **7:** 269. 1914. Many Trichoptera larvæ build their dwellings chiefly during the night, but *Hydropsyche* build their tubes and nets at all times of the day or night.

Oudemans, J. T. Etude sur la position de repos chez les Lepidopteres. Verhandel. Kon. Akad. **10:** No. 1. 1904. *Fide* Longstaff. "Lepidoptera have a sleeping dress; this dress forms a harmonious whole. The different parts which contribute to form the whole dress harmonize in their colors and usually in their patterns. The parts of the insect which are concealed during rest are quite frequently strongly contrasted in color or pattern to the exposed parts."

Peckham, G. W. and **E. G. Peckham.** Instincts and Habits of Solitary Wasps. Bull. Wis. Geol. and Nat. Hist. Surv. Ser. 1. **2:** 94. 1898. At 4:15 *Astata bicolor* thought she had worked long enough, went into her hole, closed the door behind her and remained there until 7:30 the next morning. She began the work of excavation in the morning, carried it on without haste or pause until 2 or 3 in the afternoon and retired at about 4 o'clock; the next morning she completed the nest in about an hour. They also saw this species make a shallow temporary hole for the night. When the weather was cold or cloudy *Philanthus punctatus* Say remained closely housed within the nest. Two ♂ *P. punctatus* excavated a temporary hole for shelter for the night, covered it with loose soil, remained in it from about 4 o'clock until 10 the next morning, peeping out only once at 8:30 to look around but again retreating and closing the door. ♂'s do not construct a new lodging every night but return to the same spot to sleep. Other wasps creep into crevices; often found in holes in posts. "But we are glad to put it to the credit of one ♂ that he had sufficient foresight and industry to provide a sleeping-place, and sufficient intelligence to return to the spot when the declining sun warns him that evening is approaching." Two *Crabro stirpicola* Pack. worked at nest-building without cessation throughout the night, the second day and second night—a period of forty-two consecutive hours with only one intermission of ten minutes. At 4 o'clock *Pompilus scelestus* Cres. began to investigate very carefully the plants and grasses immediately surrounding her hole; she selected a bunch of clover four inches away, and hanging to a leaf she remained motionless and fast asleep until they left her at sundown. The next morning at 8 o'clock she was still soundly asleep. After they had gently aroused her, she crept up the stem, stretched herself sleepily and slowly made her toilet.

Peckham, G. W. & E. G. Wasps, social and solitary. 1905. Female *Crabro* like those of other genera seem to use the galleries of their nests as sleeping places, but the ♂'s stop at any convenient inn. One was entertained in a hole in one of the porch posts for several nights. *Philanthus* ♂'s spend time and care in

digging a hole in the ground to which they return night after night. In *Agenia* the ♀ keeps one cell ahead of her needs and tucks herself away in it very comfortably, but the *Pelopæi*, instead of making use of their tubes, congregate in the evening about convenient crevices. Quote Banks on *Ammophila* and Brues on *Prionotnyx*. They also observed a *Pompilus* to take the greatest care in selecting a sheltered spot under some leaves where she afterwards hung herself up and slept soundly until 8 o'clock the next day.

Pictet, A. L'instinct et le sommeil chez les insectes. Arch. Sci. Phys. Nat. iv. **17:** 447–451. 1904. (Not seen.)

Poulton, E. B. Predaceous insects and their prey. Trans. Ent. Soc. Lond. **42:** 374, 664. A female *Asilus crabroniformis* asleep on a head of *Centaurea scabiosa*, strongly suggested a crumpled leaf which had fallen upon the flower. This cryptic resemblance was brought about by a remarkable attitude, the insect being in the position formed by a half somersault arrested when the ventral surface was uppermost. *Volucella inanis* readily takes flight in the sun, but in the evening it becomes semi-torpid, and if disturbed then it raises its first leg in a manner clearly mimetic of the warning attitude of its Bombus model.

Rau, P. The sun-dance of the saw-fly. Ent. News **27:** 274–277. 1916. *Macrophya sp. nov.* at rest, apparently settled for sleep, on top of box-elder leaves, before 6 P. M. on an April evening.

Rau, P., and **N. Rau.** The Biology of the Mud-Daubing Wasps. Journ. Anim. Beh. **6:** 27–63. 1916. The mothers themselves (*Trypoxylon albitarsis* Fab., *Sceliphron cæmentarium* Drury and *Chalybion cæruleum* Linne) do not use their mud nests for their own shelter but go elsewhere for the night. *Osmia cordata* when removed from its cell prematurely would creep back into its old cell or be happy to get into any crevice.

Rau, P. & N. Rau. A sleepy Eumenid. Ent. News **24:** 396. 1913. At night the *Ancistrocerus unifasciatus* Saus. would creep into the old cell of the mud-daubers' nest from which they had emerged. In keeping *Pelopoeus cæmentarium* of both sexes in cages with the nests from which they had hatched no such behavior was ever observed.

Read, C. Instinct, Especially in the Solitary Wasps. Brit. Journ. Psychol. **4.** Pt. 1. Mentions sleeping habits of wasps from Peckhams' account.

Roubaud, E. The Natural History of the Solitary Wasps of the Genus Synagris. Smithson. Rept. **1910:** 507–524. The nests of *Synagris sickeliana* are masses of yellow earth; the most recent cell is always open and serves as a shelter for the builder, which very often dies in it. *S. cornuta* L. during rare moments of rest and at night remains in her cell with her head turned outward, guarding her young.

Sanborn, F. G. Proc. Bost. Soc. Nat. Hist. **12:** 98. *Ammophila gryphus* clasping small oak twig with mandibles and feet, body elevated one-fourth inch above twig. *Fide* Scudder and Mann.

Saunders, ——. Hymenoptera Aculeata of the British Islands. p. 308. The ♂ of *Chilostoma* (a bee) usually spends the night curled up in flowers, but Smith says that at other times he has observed them hanging to blades of grass by their mandibles. *Fide* Banks.

Schwarz, E. A. Sleeping Trees of Hymenoptera. Proc. Ent. Soc. Washington **4:** 24–27. 1896. In southwestern Texas *Melissodes pygmæus* Cress., and *Colopiera wrighti* Cress. were abundant and asleep on *Celtis pallida* on the thinnest and outermost twigs and on the stout thorns, sleeping singly, the tips of the mandibles inserted in the wood and all six legs grasping the twig. Four shrubs near together bore 50 to 70 sleeping bees, and several other shrubs had small numbers. They were on these shrubs every morning. The habit reminds one of the well-known "butterfly-trees" of Monterey, California, and Appalachicola, Florida, the sleeping habitats of *Danais archippus* during their winter migration to southern localities. (No reference to the "well known" butterfly trees could be found.)

Scudder, S. H., and B. P. Mann. Attitudes in which some Wasps are supposed to Sleep. Psyche **2:** 40–41. 1877. *Ammophila gryphus?* rests at night by seizing grass with jaws and holding itself extended with or without use of middle and hind feet. *Odynerus?* seized twig with jaws and supported body in horizontal position.

Scudder, S. H. Butterflies of Eastern United States. **2:** 1602–1604. Cambridge. 1889. Postures at rest and asleep. At sleep the wings are packed away into smaller compass, with the exception of some Hesperidi; the wings erect back to back, the forewings slide down behind the hind pair so that only the latter and the apex of the front edge of the former are visible. One observation of a European *Thais* asleep in confinement with spread wings. There is more variety in the position of antennæ; some like Satyrinæ sleep with these spread wide, others tuck them between the wings, and others bring them together beside the front edge of the wings the clubs appearing beyond as if crowded out by the tight shutting of the wings.

Severin, H. H. P., H. C. Severin and **B. S. Hartung.** The ravages, life history, etc., of the melonfly, *Dacus cucurbitæ*. Ann. Ent. Soc. Amer. **7:** 191. 1914. Feeds from sunrise to ten o'clock, but during the hottest part of the day thousands may be found at rest under large leaves of plants in or near an infested field of cucurbits.

Shepheard-Walwyn, Entomologist **36:** 201. *pl. 3.* 1903. The resting position of the moth, *Plusia moneta* is most striking as it hangs by its two front legs, stretching them out to their fullest extent.

Sladen, F. W. L. The humble-bee, p. 63, 267–268. 1912. A humble-bee is usually in an animated state, abdomen pulsating, head held erect and antennæ pointing at attention, but occasionally a queen is found resting on a flower with her head hanging down and antennæ resting on her face, evidently indulging in a nap, for she awakes with a start when disturbed. Before the cares of motherhood have come upon her the queen is very fond of dropping off to sleep in the warm sunshine or in the newly found nest. *Psithyus*, the usurper-bee, becomes a temporary lodger in the nest of *Bombus*, returning to it for meals and to spend the night.

Slevogt, ——. Haben Insekten Ortsinn? Soc. Ent. **19:** 37. *Aeschna* has permanent night quarters. (Not seen.)

Soule, C. G. Sound Sleep of *Lycaena americana*. Psyche **5:** 42. 1888. She observed in the vacant lots about Boston "that as one side of the street grew shady toward sunset *L. americana* might be seen clinging to grass blades with wings somewhat drooped, suggesting that the muscles were somewhat relaxed by sleep." One was carried on a grass stem five blocks undisturbed. Later experiments always found the butterfly in the same position more than half way up the grass-blade, head up, wings drooped to an acute instead of a right angle with the body.

Stiles, C. W. (Discussion.) Proc. Ent. Soc. Washington **4:** 27. 1896. It is difficult to conceive of the sleep of a tape-worm, *Oxyurus;* yet it undoubtedly has long periods of rest and is active in the evening. Many protozoa are still for a long time; *Acalephs* have also a resting period; in necrobiosis sleep may last for eight or ten years.

Tonge, A. E. Resting attitudes of Lepidoptera. Proc. S. Lond. Ent. Soc. **1909:** 5–8. *Pl. 2–3.*

Turner, C. H. Literature for 1914 on the Behavior of Spiders and Insects. Journ. Anim. Beh. **5:** 439. 1915. Reviews Beutel-Reepen on sleep of solitary bees, Williams on *Prionoryx thomæ* and Frohawk on butterflies of the family of Lyncænidæ.

Turner, C. H. Notes on the Behavior of a Parasitic Bee of the Family Stellidæ. Journ. Anim. Beh. **1:** 374. The bees hatched from a nest of the mud-dauber, and at night or whenever the room was darkened the bees would retire to the mud cells.

Vavilov, ——. Quoted in Journ. of Hered. **7:** 43. 1916. Wild geese "swim to the selected open shore, where they get out, lie down, and fall asleep. The old birds alone do not sleep, but divide the watches, and, if they hear anything suspicious, at once wake the whole flock with a loud cry of warning."

Watson, J. B. Behavior, an Introduction to Comparative Psychology. p. 112. 1914. Night and day periods of activity are purely instinctive, since no structural peculiarities account for the differences.

Watson, J. B. Journ. Anim. Beh. **2**: 431. 1912. Quotes Werner (Biol. Centralbl. **31**: 41–44.) on sleeping habits of fishes, *Amiurus nebulosus*, *Misgurnus fossilis* and *Cabitus talnia*. The bodily attitudes taken in sleep are quite different for different species, even in nearly related species. In general there is a complete cessation of activity, a certain chosen bodily attitude and almost complete stoppage of breathing. Very light contact is sufficient to awaken the fish.

Werner, F. Ueber die Schlafstellungen des Fische. Biol. Centralbl. **31**: 41–44. Reviewed by Watson.

Westwood, J. O. Introduction to Modern Classification of Insects **2**: 211. 1840. *Scolia interrupta* and *S. 4-punctata* ♂'s, which are extremely sluggish, are found crowded on the ears of grass near the seaside, in groups or societes of 20 or 30 where they pass the night and make no attempt to escape. The ♂'s of *S. 6-cincta* are found in similar localities. Quotes from Latreille that in night or bad weather *Fœnus jacubator* fix themselves by their jaws to the stalks of different plants and are then almost in a perpendicular position.

Williams, F. X. Monograph of the Larridae of Kansas. Kans. Univ. Sci. Bull. **8**: 187. 1913. Larridæ ♂'s make holes probably as a place of retirement during unfavorable weather and at night. A black species of *Tachysphex*, probably *fuscus* or *terminatus* was observed digging a hole in the sand and closing the retreat from within. *Plenoculus apicalis* and *Niteliopsis affinis* have much the same habits as the above.

Williams, F. X. Larridae of Kansas. Kan. Univ. Sci. Bull. **8**: 210. 1913. The males of the Larridæ are "frequently seen on flowers or basking in the sun. They were only observed to work when excavating short tunnels, in which they probably passed the night."

Williams, F. X. Notes on the Habits of Some Species of Wasps that Occur in Kansas. Kans. Univ. Sci. Bull. **8**: 227. 1913. *Priononyx thomæ* ♂'s in common with many other species of Sphegidæ congregate in some numbers on weeds where they pass the night or remain during unfavorable weather. Such "clumps" are common on Russian thistle in western Kansas.

Wittfield, ——. The southern *Euphoeades palamedes* sleeps with spread wings. *Fide* Scudder.

APPENDIX

From a physiological point of view the concluding remarks by Fiebrig are suggestive, and we here append an English translation of that part of his paper, pp. 347-354.

Those characteristics, which are manifested in the true sleep of vertebrates, are also present in the sleep of insects, especially of the Hymenoptera. These characteristics are principally:

Relative immovability,

Unconsciousness,

The same or similar behavior under various external influences (light, approach, contact),

Similar behavior when going to sleep and on awaking,

Adjusting of the periods of sleep to the changing periods of day and night,

in short, very often, manifestations which lead to the conclusion that the habits of sleep are protective. But, while most of the

remaining accompanying manifestations, as, for instance, the response to external stimuli, seem to correspond to those well-known and familiar forerunners of sleep, the specific rigidity among insects of the (cataleptic) muscular strain is just the opposite of our usual conceptions of sleep. To be sure, we recognize certain sleep-like manifestations, which at present are causing much discussion, resulting from hypnotism, often bringing about most surprising results, and, just as among bees, showing the strangest departures from normal rest positions. We also speak of an hypnotic sleep, a rigidity brought on by hypnotism. We do not understand as yet the physiological processes of these cataleptic conditions observed among vertebrates. Do similar physiological processes exist in the sleep of insects, in the clinging colonies of bees and wasps, as take place in the hypnotic sleep of vertebrates? It is a well known fact that not only man is susceptible to this form of sleep, but also many, psychologically poorly developed, vertebrates, as, for example, the hen. Is perhaps this hypnotic-like sleep of insects the forerunner of our present fully developed form of sleep, in which, because of the high development of the psychological, i. e., the nervous system, the assimilating and reviving processes are more complete and radically more intensive? Such cataleptic or hypnotic sleep in the higher vertebrates could be regarded as an atavic form of sleep. This view would receive considerable support if we were to assume that such a sleep was the rule among cold blooded animals of the present day and particularly among the giant lizards and amphibians of prehistoric ages. The fact that this so-called "hypnotic" sleep is of a decidedly passive nature and only brought about through the influence of an external organism need be regarded of only secondary importance for our comparison, in which the cataleptic manifestations accompanying sleep are the vital considerations; it can readily be assumed that among insects instead of a person an object, i. e., any external factor, to a certain extent could act as hypnotizer (for example, light or its absence.)

Although we may compare the manifestations of sleep among insects with a known form of sleep, we have not advanced very much further in knowing its nature, particularly so, since the physiological nature of hypnotic sleep is, I believe, still unknown. It would be carrying me too far were I to consider—even

speculatively—these apparently most complicated manifestations further. One thing I should like to call attention to particularly, however, and that is the significance of the organs of sight. Sight seems to be the sense which is most intensely affected by sleep, judging from the susceptibility of a sleeping organism to light stimuli, particularly the dependence of sleep on the amount of light. We are forced to the conclusion that it is the optic nerves which usher in sleep, which perceive and transmit the first intimation of sleepiness, which give the body the signal that it is time to retire. (Just think of the drooping eyelids of tired persons.) The same is true, as we have seen, of the sleep of insects. On comparing the organs which bring this about—the eyes—which transmit the sleep producing sensations, we find a very material difference. On the one side we have the one lens eye (closed by means of a lid) of the vertebrates, and on the other the facet eye of the insects. Are these differently constructed organs of sight in any way connected with the variations in sleep manifested by these two widely separated groups? Picture the effect of light, positive or negative, on insects, and its effect on the nervous system of the articulates with relatively few ganglia: many eyes and few nerve cells opposed to one pair of eyes and a single nerve center with a highly diversified nervous system among mammals and birds. Would it not be conceivable that, since sleep manifestations are so closely connected with the eyes (the optic nerves), they would assume certain definite forms according to the kind and construction of the organs of sight? According to my judgment all the great variations in the organization* of the widely differing groups of animals which are expressed in various forms of sleep, also cause the various uses of the limbs, especially of the muscles; we have only to call to mind the great difference in the sleep of warm and cold blooded vertebrates, which, undoubtedly, is caused primarily by a difference in respiration, i. e., conditions of blood circulation. The manifestations, which among cold blooded vertebrates have a certain resemblance to sleep, are so different from those conditions among mammals and birds, not even a sensitiveness to light seeming to be present, that it is doubtful whether among cold blooded animals conditions occur which can be designated as "sleep" at all.

*It would perhaps be simplest to ascribe the specific manifestations of sleep among insects to the little developed circulatory system.

It must seem very peculiar, indeed, that, while we are unable in general to recognize an ability to sleep among cold blooded vertebrates, the nearest relatives of the sleep-demanding mammals and birds, we should have for so large a number of the much lower articulates such convincing evidence of a sleep similar to that of the highest organized animals. As far as my investigations have gone this seems to be the case, the sleep of insects appearing to be real sleep, while those sleep-like conditions which are found among cold-blooded vertebrates, can hardly be admitted into the catagory of actual sleep manifestations. Startling as these conditions may seem at first glance, upon reflection some of their surprising effects become clearer when we recall how totally different is the distribution of the physical and the psychological qualities in these widely separated groups.

In conclusion I wish to call particularly to mind that among warm blooded animals those seem to have the most pronounced form of sleep which have the intensest manifestations of life (particularly again the birds). With such intensive living the busy workers certainly deserve a few hours of rest; we can surely appreciate their intensive desire for rest, and that insects also "get tired and sleep."

Sleep is a reflex of life, indeed, of the active manifestations of life, the reflected image of the physical and psychological activity of an organism. From this point of view we shall be able to understand more clearly certain forms of sleep. In the same way we shall be helped in explaining also the sleep of insects, the richest group in genera in the animal kingdom, which we meet at every step and whose existence, whose lives are still so little known to us.

REDUCING MALARIA BY REDUCING THE NUMBER OF ANOPHELES WITHIN BUILDINGS.

By JAMES ZETEK,
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Malaria may be entirely eliminated and in time become an unknown disease. But to achieve this desired end soon, calls for unprecedented co-operation extended over a very large territory, and it would require vigorous anti-malarial work for many years. The cost of such work will be very heavy, however, an investment as great, if not greater, than the Panama Canal. The lives and time saved by such eradication, and the increase in energy and longevity which would follow, expressed in dollars and health, would soon repay with interest all that had been spent. A campaign such as this could, with very little additional cost, eliminate a few of the other insect-born tropical diseases.

The purpose of this paper is to show how in a given camp malaria may be greatly reduced by the reduction in numbers of the *Anopheles* which gain entrance into buildings. By *Anopheles* I mean those species only which are known to or are supposed to transmit malaria. It is essential, therefore, to become acquainted with the mosquito fauna of a given region and learn which members of it are pathogenic. The observations recorded herein were made at MiraFlores construction Camp, Canal Zone, at which point are the last two flights of locks to the Pacific entrance. The buildings of this camp are of similar size and shape, located in straight, parallel rows. This uniformity in design and position made the interpretation of our data easy. The following sketch aims to give all the essential data regarding MiraFlores camp. All doors are indicated excepting such as lead only to screened-in porches. The symbols used signify: W-I—West Indian negro; S—Spaniard and other European; C—Columbian and Panamanian; E-I—East Indian (Hindoo); W—white American. Unmarked buildings are offices, stores, schools, hotel, police station, etc. Dots represent position and number of insect traps affixed to the buildings. All doors, windows, etc., are well screened with 18-mesh copper wire screen, and cracks and holes in floors are stopped-up as well as

could be expected. The site of the camp is at present under the waters of MiraFlores Lake. The observations reported were made in the year 1912. I am indebted to Messrs. Shropshire and Chiddester for aiding me considerably at this station.

There were only five possible sources for extensive *Anopheles* breeding, and regular (almost daily) inspections were made of the entire territory to locate *Anopheles* breeding. The only *Anopheles* found to be predominant in the mosquitos caught in the camp was *A. albimanus* Wiede., and excepting during the dry season (Jan. to Apr.), when *A. pseudopunctipennis* Theob.

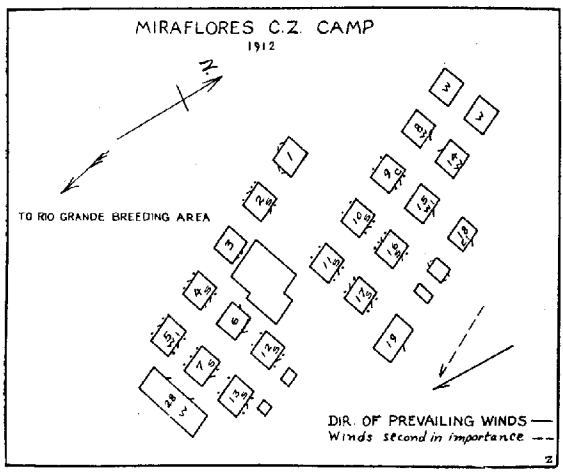

FIGURE 1

appeared in sparce numbers, was practically the only Anophelene represented in these catches. During the first six months of 1912, only one *A. apicimacula* D & K, one *A. argyritarsis* Rob-Desv. and two *A. malefactor* D & K were caught. The only extensive breeding of *A. albimanus* occurred in the winding Rio Grande, south-west of MiraFlores camp. The five possible breeding centers were: 1, Rio Grande; 2, Rio Cardinas; 3, Rio Cameron; 4, Cocoli water reservoir, and 5, the ditch in the Canal Prism. During the dry season the Cameron river was an unusually favorable habitat for *A. pseudopunctipennis* and *Uranotænia geometrica* Theob., but no influx of these species was ever noted in MiraFlores. By means of liberating

at these and other stations mosquitos sprayed with aquaeous anilin dyes, it was determined that the big influx of *albimanus* came from the extensive breeding area in the Rio Grande. The data concerning flight is reserved for a future report.

Exact counts were made of the mosquitos caught in traps and inside of houses; these counts are differentiated as "trap catch" and "hand catch" respectively, and are further divided into two groups, "Anopheles" and "Culex spp," the latter representing all non-anophelinæ. All counts were made daily, but in the results presented in this article, this data is greatly simplified. The trap catch represents those mosquitos which entered the Chas. H. Bath type of insect trap affixed to buildings. This trap is described in my previous paper (Ann. Ento. Soc. Am. vol. VI No. 1). These traps were placed on the sides facing S-W and N-E. The method of catching mosquitos inside of barracks is also described in my former paper. Although the cheapest labor was used, W. I. negroes, this work could hardly have been done better.

EFFECT OF TRAPS AFFIXED TO BUILDINGS ON THE NUMBER OF MOSQUITOS WHICH ENTER THE BUILDINGS.

Two buildings were used to determine this influence. The following table gives a comparison of these two buildings:

Camp 5.	Camp 15.
Contains 75 W-I negroes.	Contains 75 W-I negroes.
Two doors opening to exterior.	But one door opening to exterior.
Four traps.	No traps.
Nearest to breeding area.	Farthest away from same.
Of total mosquitos caught in both camps, this camp's share was but 33%.	Of this same total, this camp claimed 67%.

This comparison shows that both buildings are practically the same, excepting that one has traps while the other has none. The building farthest away from the breeding place, and with but one door, had 67% of the total mosquitos caught in the two camps.

The record was kept of the cases of malaria reported from each of these camps. During the 175 days representing this record, 29 cases came from camp 15 (without traps) and but 12 cases from camp 5. It may be said that there is no conclusive proof that these cases had their origin from the mosquitos present inside of the barracks. But granting this, it surely

appears that in two camps so nearly alike we ought to expect about the same number of cases in each. The increase of 250% in camp 15 is due to the fact that on account of no traps, more mosquitos entered the building, and therefore the higher malarial rate.

The weekly summary for these two camps is represented in the following chart. The weekly index was gotten at in the following manner. If during the week twelve collections were

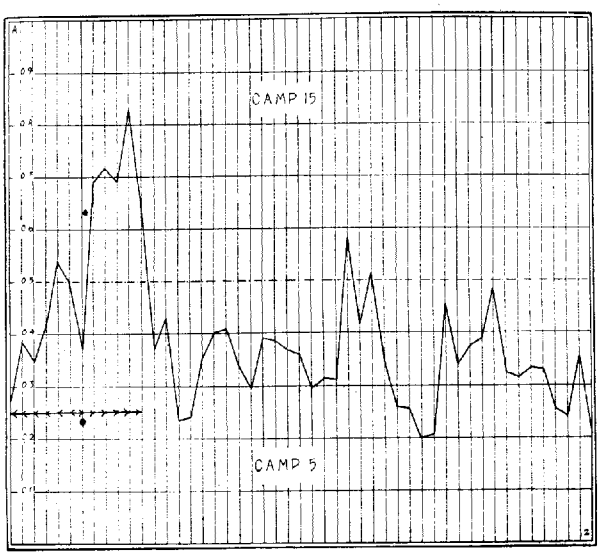

CHART A

made in camp 5, then the total mosquitos (anophelene only) caught in that week were divided by twelve. This gave an average per one catch per week. The same was done with camp 15. Then the average catch of both camps for the same week was added together and considered as 100%. The following notes should be read in connection with the curve. That portion of the chart included within the series of arrows represents data for camps 5 and 10 for during that time camp 10 was used as a W-I barrack. Both camps had four traps each, but camp 10 had but one door while camp 5 had two. Very often extreme fluctuations are due to existing cracks in the floor

through which Anopheles may enter. This is well illustrated by the behavior of the curve at the point marked by a black disc. At this period all cracks in camp 10 were stopped-up. Note the sudden up-shoot of Anopheles in camp 5 due to this. Up to this period the cracks present in camp 10 were the equivalent of an extra door. The remainder of the chart is for camps 5 and 15, and the curve is almost as significant as the familiar campaign literature advocating vaccination against small-pox.

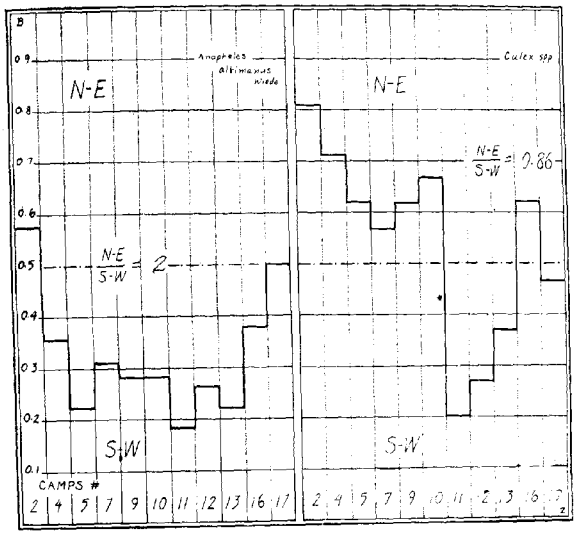

CHART B

PECULIARITIES OF TRAP CATCHES.

Eleven of the buildings of MiraFlores camp had insect traps attached to them. Chart B presents a comparison of the trap catch of the north-east and south-west sides of each building. The percentages were arrived at the following manner: the total number of *Anopheles* caught during the nine weeks from Jan. 29 to Mar. 30, 1912, in the S-W traps were divided by the number of traps to give an average per trap. The same was done for the N-E traps. The total of these two averages in each building was taken to represent 100%. The record for each building was differentiated into *Anopheles* (almost wholly *albimanus*)

and Culex spp. (non-anophelinæ). The Anopheles curve shows double the number of these mosquitos in the N-E traps. There appears to be no discrimination as to nationality of the inhabitants of the several buildings. Emphasis is placed upon the fact that north-east traps contained the bulk of the anophelenes. Reference to the map shows the relation of wind direction to position of traps. The *Anopheles* did not enter freely the S-W traps because this entailed flying against considerable wind. The bulk of these mosquitos flew around the lee side and entered the N-E traps. This preference for the lee side of houses was noted in every case where traps were present. It therefore follows that entrances to buildings should always be on the windward side and not on the lee side.

The culex curve shows conditions opposite to that for the anophelenes. There is no doubt whatever that the culex breeding in the caison to the west of the camp supplied the influx of culex, and being more powerful fliers, did not find themselves forced to seek a wind-protected side. I have no positive evidence of actual flight or even gradual infiltrations of culex from the Cameron River northeast of the camp.

PECULARITIES OF THE HAND CATCH DUE TO NATIONALITY OF THE INHABITANTS.

At first thought it appears improbable that the particular nationality may influence the number of mosquitos that gain entrance into the building. The following table is presented to show what influence was observed at MiraFlores camp.

TOTAL PER FOUR WEEKS' PERIODS, HAND CATCH.
(Avr. per one camp, 1912.)

FOUR WEEKS ENDING	SPANIARD	COLUMBIAN	WEST INDIAN	EAST INDIAN	TOTAL
February 24.....	459	959	477	75	1970
March 23.....	434	892	357	42	1725
April 20.....	486	1274	353	31	2144
May 18.....	2321	3252	1781	410	7764
June 8.....	1140	2724	1453	422	6139
(Only 3 weeks)					
AVERAGE PER DAY, SAME PERIODS AS ABOVE.					
	20.	34.3	20.5	2.7	77.5
	19.	32.	12.7	1.5	65.2
	17.4	45.5	12.7	1.1	76.7
	83.	116.	63.6	14.6	277.2
	54.3	129.7	69.1	20.	273.1

All barracks were of about the same size, type, and held about the same number of people each. Yet the Columbian camp had a much larger percentage of mosquitos than any other camp, and were it not that it had four traps, the amount of mosquitos would more than be double. To understand this pecularity, it is necessary to understand the peculiar behavior of these several types of people, and I briefly outline the more important of these peculiarities. The Spaniard as a rule prefers to lounge outdoors until quite dark. The door to his barrack is practically closed during dusk, the period of maximum mosquito (anophelene) activity. The West Indian is much like the Spaniard in this respect. The Columbian, on the other hand, is much more restless, goes in and out of his camp during the hours of dusk with much frequency and often leaves his doors wide open. The East Indian stays inside of his barrack almost exclusively. Therefore the entrance to his home is kept closed most of the time. Constant opening of doors during the period of dusk, particularly doors on the lee sides of buildings, will admit large numbers of malarial mosquitos.

The malarial rate for the four types is given in the following comparative table.

MALARIA STATISTICS, JANUARY 2 TO APRIL 27, 1912.
(17 Weeks.)

A. Population.

Spaniards	503
Columbians	60
West Indians	102
East Indians	47

B. Malaria Data.

	Total Cases	Avr. Num. per Week	Num. per 100 Sick per Week
Spaniards	153	9.2	1.85
Columbians	11	0.7	1.18
West Indians	44	2.6	2.55
East Indians	2	0.1	0.21

The East Indian (hindoo) is the one with the least malaria, due not to immunity, but becasue of his habit of staying indoors during dusk. Economically considered, the hindoo is the least expensive type of labor, considering cost of hospital treatment. The Spaniard and West Indian, roaming outdoors during dusk, when anophlenes are most active, and being quite susceptible to malaria, show the biggest percentage of cases. The Columbian, native of the region and a veteran

of malarial attacks, although his camp has the most malarial mosquitos, shows less fever than the Spaniard. This low percentage is due to a partial immunity "earned" through several previous attacks. I mean by partial immunity more particularly the absence of high fevers; the majority of the laborers whose blood teems with crecents but have no fever, do not present themselves for treatment. Only those cases which come to the office of the District Physician enter our statistics. Another interesting peculiarity is observable; although the Spaniard is more susceptible to malaria than is the West Indian, his rate is lower. This is due to the fact that the Spaniard makes liberal use of the liquid quinine freely dispensed at the messes and places of work, thus reducing and eliminating much malaria. The Spaniard looks upon malaria as just so much money lost; the West Indian is of a much livelier nature, not caring if he is losing money.

No few cases of malaria among the West Indian are repetitions, i. e., a recurrence of the fever after the patient left the hospital. Our hospitals cannot take care of malarial cases for a period longer than after the fevers subsided and the blood smears reveal no crecents or but a few. The patient is always advised to continue quinine treatment for at least a month after dismissal. It should be made clear that the figures presented are for the dry season period, and do not include the high increase in malaria from May to November, and hence may be considered as true indexes of actual susceptibility.

SUMMARY.

The observations reported are applicable largely to temporary construction camps in malarious regions, and unless permanent settlements are in view, screening, traps and mosquito catching indoors will suffice to keep malaria at a very low rate. However, a certain amount of control work must always be done at larval habitats of the mosquitos. The degree of such anti-malarial work (ditching, fills, etc.,) will depend entirely upon whether the locality is to become a permanent settlement, or whether that locality, if untreated, would prove a serious menace to other localities.

Traps should at first be placed on all four sides of buildings to determine which side attracts the most mosquitos. Our

data indicates that the *Anopheles* of Panama enter largely the traps on the lee sides of buildings. Probably this holds true elsewhere, but this fact should be determined at each new locality. Doors should be on the windward side of buildings, and they should be opened and closed as little as possible during dusk, the period of maximum *Anopheles* activity.

Houses should be well screened with 18-mesh wire screen, and all cracks, holes and openings in walls or floors must be stopped-up.

Mosquitos within buildings should be caught and killed daily. The best method is to use a killing tube such as described in these Annals, p. 16, vol. VI. A satisfactory scheme is to darken all windows but one, and to catch the *Anopheles* which go to the undarkened window. The time for such collections is at early dawn.

Ancon, C. Z., June 10, 1915.

THE CITRUS MITE NAMED AND DESCRIBED FOR THE FIRST TIME.

By E. A. McGregor,
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U. S. Dept. of Agriculture, Washington, D. C.

The discovery which forms the text of this paper was the outcome of a study of types in the red spider collection of the Bureau of Entomology. Out of respect for previous workers in the acarid group the author wishes to state here that the anatomical studies, on which the present paper is based, were conducted with the aid of an oil-immersion lens and a camera lucida attachment. It has developed, through the studies of Mr. H. E. Ewing and the present writer, that the microscopic structures which constitute the taxonomic characters in the red spider group must be examined more critically than has been the practice with earlier workers if satisfactory specific demarcation is to be secured.

In 1885 Riley published* the original description of a mite under the name *Penthalodes mytilaspidis*, stating that "it possesses three claws, and that it is certainly predatory upon scale insects" on citrus trees. In 1900 Banks† re-named the species *Tetranychus mytilaspidis* stating that "This species is a true *Tetranychus* and not a *Penthalodes* * * * On careful observation I cannot discern any division to the lower (tarsal) claw in the many specimens examined (including Riley's types). It * * * probably feeds, like the other species of the genus, on plant juices." In his figure Banks shows only two divisions to the tarsal claw.

The writer's studies of Banks' red spider types included the slide which he says is probably the original type slide of Riley's *Penthalodes mytilaspidis*. In connection with this study the author went carefully through all of Hubbard's and Riley's acarid material in the National Museum and in the Bureau collection in an effort to locate material antedating that of the slide which Banks considers to be the valid type of *Penthalodes mytilaspidis*. Nothing was found that cast a shadow of a doubt

*Hubbard, Orange Insects, p. 216.
†"The Red Spiders of the United States, Div. of Ent., Tech. Ser. No. 8, p. 71.

on the validity of the Hubbard slide, and we may safely accept the material as representing the type specimens of the above species.

A study of the structure of specimens on Riley's type slide (see plate XIII) confirms his diagnosis of their identity. Riley states it "is one of the 'harvest-mites' belonging to the section Eupodidæ and comes nearer *Penthalodes* Murray than to any other defined genus, having 6-jointed legs (see plate XIII, fig. 2), of about equal length, * * * 'head' distinctly separated, narrow, elongate, conical. Mandibles scissor-like, projecting. Palpi * * * 4-jointed (fig. 1) * * *. Cephalothorax * * * merging posteriorly into the abdomen, so as to have no distinct division * * *. Surrounded by rather long and stout bristles * * *. Legs about equal in length * * *. Claws 3, much curved at tip * * *. (See plate XIII, figs. 3 and 4).

Considering the limitations of the microscopic equipment in use by workers of Riley's time, the above description tallies very well with the structures as shown in plate XIII. Some of the finer details do not conform to the original description, which is quite excusable. For example, Riley overlooked certain characters of the palpi (see plate 1, fig. XIII), and the plumose appendages of the tarsus (see plate XIV, figs. 3 and 4), which are invisible with magnifications weaker than the oil-immersion lens.

Finally, the notes on field observations, published at the time of the original description, prove that *P. mytilaspidis* is quite distinct from the citrus mite. Hubbard stated that "the eggs are sherry-brown in color, quite large and globular, and are usually deposited singly upon the leaf among scales, or strung like amber beads upon strands of spiders web * * *." Regarding the citrus mite, it has long been known that the egg is bright red in color, and is not globular, but lenticular with a slender stalk projecting from the center of the top side. Hubbard further states that "This mite is also very rapid in its movement." In this respect it agrees perfectly with the travel of predaceous mites—which Riley and Hubbard claimed the species to be. On the other hand it is entirely at variance with the rule in the group for red spiders to be very rapid of movement, and the citrus mite is no exception.

Banks concluded that the citrus mite is identical with Riley's *Penthalodes mytilaspidis* which is clearly not the case.

As a result the citrus red spider has never been technically named or described. It therefore becomes necessary to name and describe it.

Tetranychus citri sp. nov.

ORIGINAL DESCRIPTION.

Distinctly velvety-red in color. In size larger and more obese than the majority of red spider species. Female: length, .305 mm., width, .230 mm. A single eye cornea on each side, twice as far behind the subfrontal bristle as the latter's distance from the frontal bristle. Dorsal bristles long, stout, arising from prominent tubercles (see Plate XIV, Fig. 3); subfrontal bristles barely 3 times as long as frontals (see Plate XIV, Fig. 2); bristles sparsely pilose. Legs paler than body color, bristles 26, arranged chiefly in four longitudinal rows (see Plate XIV, Fig. 8). Mandibular plate abruptly narrowed anteriorly, tip rounded with an almost imperceptible emargination. Palpus is provided (see Plate XIV, Fig. 9), with a comparatively short "thumb," bearing a terminal, slightly clavate "finger" whose base is less than half the width of tip of "thumb"; with two pseudo-fingers arising on either side of the upper distal corner, which are not greatly thicker than hairs; on upper side hardly midway to base with a small "finger" between which and base are two, short, stout hairs; near the lower center of the outer side of the "thumb" with a hair which reaches to the tip of the terminal "finger"; with the claw on the penultimate joint stout and reaching to the dorsal "finger"; a strong hair arising laterally from the center of the penultimate joint, another arising from the center of the dorsal face of this joint which equals the claw, and a short, weak hair with its origin on the inner base of claw; and with a very strongly tubercled spur arising distally from the top of the antepenultimate joint of the male (see Plate XIV, Fig. 7). The legs (see Plate XIV, Fig. 1), are relatively short; femur somewhat more than twice as long as wide, barely equalling tarsus; tibia a little longer than patella which is one-third again as long as trochanter. Tip of tarsus (see Plate XIV, Fig. 6), bears a claw which is rather straight for two-thirds its length and then bent sharply downward; at a point one-third the length of the claw from its base arise six slightly curved spurs whose tips surpass that of the main claw: the four usual capitate hairs arise two on either side of the base of the claw.

The male is considerably smaller than the female (length .216 mm., width .146 mm.), abruptly narrowed posteriorly. The legs appear longer in proportion to the body than in the case of female, and are salmon pink. The distribution of dorsal bristles (see Plate XIV, Fig. 8), is similar to that of female. Penis (see Plate XIV, Fig. 4), comparatively short; inner lobe long, rod-like, about 3 times as long as the shaft; shaft very stout and short, becoming abruptly smaller distally, and bent upward at an angle of 120 degrees to form the attentuate hook which is considerably longer than the shaft; basilar lobe present on upper side of shaft as a strong, conical projection; hook possessing no barb, being spine-like terminally.

The egg is bright red in color, sphero-lenticular, with a vertical stalk arising from the center of the top side which in length is about twice the diameter of the egg. Several guy fibrils radiate downward from the apex of the stalk to the leaf surface, thus giving additional attachment to the egg.

Type No. 20362, U. S. Nat. Mus.

The type material is from Orlando, Florida, March 7, 1916, from the leaves of lemon, collected by W. W. Yothers. The species is in the group containing *T. yothersi* McG. and a species soon to be described by the author, of the United States, and *Paratetranychus* (*Tetranychus*) *pilosus* Zacher (Can. & Fanz.) and *P. ununguis* Zacher (Jac.) of Europe.

NOTES

Mr. Yothers, who for years has been engaged in studying the entomology of citrus trees in Florida, writes as follows. "*Tetranychus mytilaspidis* is most abundant during the spring of the year. I would say its period of maximum occurrence is from the first or middle of December until the first of May. It occurs most abundantly on lemon and sour orange, and it appears in great numbers in nurseries where these species are grown for stock upon which to bud. I have seen it so abundant on sour stock as to cause the stems of the young trees to turn blue for a distance of two feet from the top downward. Its next most favorable food plant is the grapefruit. I rather doubt that it is of any great economic importance on this fruit. It also can be found on sweet orange, but it is of little or no importance on this fruit."

The citrus mite was introduced into California from Florida on nursery stock about 1890. While the species does not seem to be as injurious in Florida as the so-called 6-spotted mite, its work in California, as early as 1900, was such as to demand urgent action. It is an interesting problem to account for the fact that the citrus red spider is severest as a pest of sweet orange in California, whereas in Florida it all but forsakes the sweet orange and is only severe upon lemon, sour orange, and grapefruit.

The citrus red spider on orange in California produces a silvering, dwarfing, and dropping of the fruit, and also causes discoloration and dropping of the foliage. It gives trouble in packing houses since it readily attacks the picked fruit. This species is doubtless the most injurious of those found on citrus trees on the Pacific Coast.

EXPLANATION OF PLATES.

PLATE XIII.

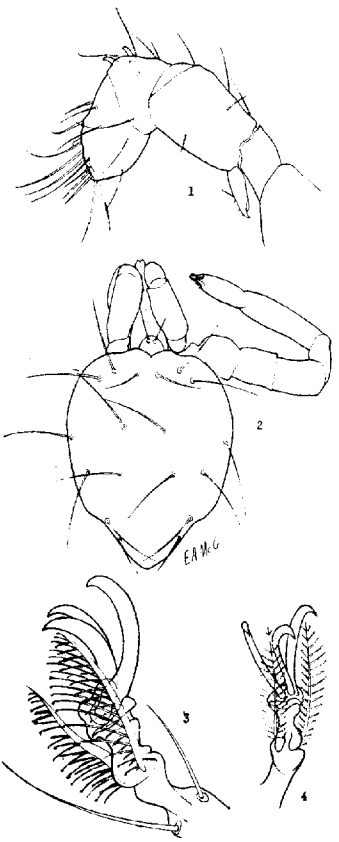
Penthalodes mytilaspidis Riley.

Fig. 1. A nearly lateral view of palpus.
Fig. 2. Dorsal view of adult showing distribution of bristles, and right foreleg.
Fig. 3. Tip of tarsus, showing appendages (lateral view).
Fig. 4. Same (ventral view).

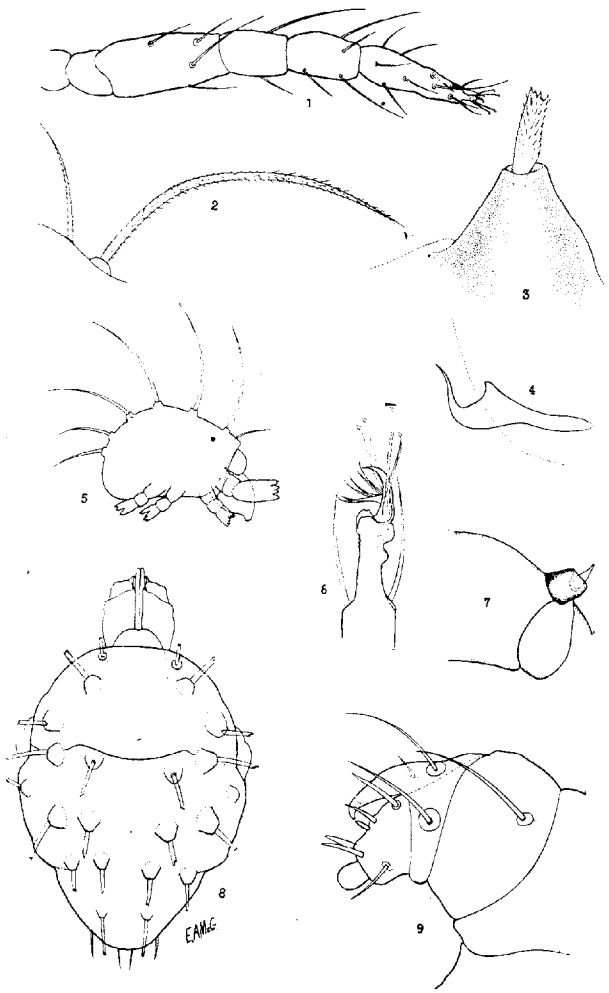
PLATE XIV.

Tetranychus citri sp. nov.

Fig. 1. Right foreleg (dorsal).
Fig. 2. Frontal and subfrontal bristles.
Fig. 3. Attachment of dorsal bristles to tubercle.
Fig. 4. Penis.
Fig. 5. Profile view of female (only proximal portion of legs shown). X 166.
Fig. 6. Tip of tarsus with appendages.
Fig. 7. Section of palpus of male showing tubercled spur.
Fig. 8. Dorsal outline of male showing distribution of dorsal bristles. X 436.
Fig. 9. Left palpus of female (outer view) showing "thumb," claw, and other appendages.



E. A. McGregor



E. A. McGregor

NEW MISCELLANEOUS CHALCIDOID HYMENOPTERA WITH NOTES ON DESCRIBED SPECIES.

By A. A. GIRAULT.

Ablerus peruviana new species.

Female: Length, about 1.10 mm.

Ovipositor half the length of the abdomen, white tipped. Dark metallic green, the following parts silvery white: Vertex, scape except bulb and middle, apical half of the pedicel, funicles 2 and 4, trochanters, knees, tips of tibiæ and middle three joints of the tarsi. Venation dusky, base of marginal vein and the stigmal vein pale. Fore wings with a distinct, oblique (caudo-distad), sooty cross-stripe from the distal two-thirds of the marginal vein and the side of the stigmal. Marginal fringes of the fore wing short, the longest not an eighth of the greatest wing width. Pedicel somewhat longer than wide, barely shorter than funicle 1 which is over twice longer than wide; funicle 2 thrice longer than wide and longest, 4 slightly shorter than 2, 3 slightly longer than wide. Club longer than the two preceding joints combined. Mandibles tridentate.

The male is about the same but the antennæ are wholly black; funicle 3 wider than long, the others subequal and nearly thrice longer than wide; club unjointed, longer than the funicle joints (any one).

From a pair on a slide in the U. S. N. M., from Coscomba, Peru (C. H. T. Townsend).

Types: Catalogue No. 19929, U. S. N. M., the above specimens.

Pentastichus xanthopus Ashmead.

The antennæ are as in *Tetrastichus*, the two ring-joints rather large and distinct but the club is only 2-jointed and with a short terminal nipple. Sculpture usual. Fore wings as in *Tetrastichus*, the marginal fringes barely longer than usual (*i. e.*, not extremely short). Venation yellow. Thorax as in *Teirastichus*. Dark metallic green. Legs and antennæ golden yellow. Propodeum short, with at least a median carina. Funicle joints subequal, but 1 a little longer than wide, 2 and 3 each a little wider than long. The genus is valid. Original description otherwise correct.

From 1 ♂, 2 ♀ types in U. S. N. M. (♀ wings, 3 antennæ and head on a slide).

Ablerus perspeciosus new species.

Female: Length, 0.65 mm., excluding the ovipositor which is white at tip and extruded for a length equal to a fourth of the abdomen.

Like *capensis* Howard but may be distinguished from that species in that the fore wings bear a third fuscous patch which is proximad from the base of the marginal vein and which is long-cuneate and densely ciliate; it is oblique and extends nearly to the middle of the second infuscation, a broad cross-stripe which differs in shape from the one in *capensis*, being straight with parallel margins, narrowing to a sort of neck cephalad, the neck against the base of stigmal vein and bearing a dense patch of black bristles; the distal cross-stripe is also different, shaped like an inverted ? but without the dot (it is like a spread bat in *capensis*). Moreover, the legs are concolorous except the knees, tarsi (except joint 5) and distal half of all tibiæ. Head white with a cross-stripe of brown-black across below the eyes. Scape (except at base and a broad middle portion), distal half of the pedicel, funicles 2 and 4, silvery. Funicle 3 a little longer than wide, 1 and 4 subequal, twice longer than wide (4 stouter and not quite that length), 2 slightly shorter than 1. Pedicel barely shorter than funicle 1. Parapsides white at distal apex. Cephalic tibiæ all dusky save at tip.

Described from four females on a slide labelled "from *Diaspis pentagona*. · Nishigahara, Japan, July 16, 1909. S. I. Kuwana, No. 33."

Types: Catalogue No. 19930, U. S. N. M., the above specimens.

Habrocytus obscuripes Ashmead.

Resembles *Aetroxys callidii* Ashmead but that species has pubescence as in *Catolaccus* and the postmarginal vein is distinctly shorter than the marginal (mandibles not examined). Colored like *Rhopalicus coloradensis* Ashmead but more slender, the parapsidal furrows slightly longer and slightly more complete in that species and funicle 1 there is about twice longer than wide, here only about a half longer than wide; also in the larger species, there is an obtuse cross-carina on the distal scutellum. The mandibles are alike in both, 3- and 4-dentate. Somewhat like *Cecidostiba dendroctoni* Ashmead but the latter has both mandibles tridentate, the incomplete parapsidal furrows are more meso-transverse and the antennæ more slender, the funicle joints longer, 1 over thrice longer than wide, 2 and 3 each nearly as long as 1.

Many specimens reared in connection with the strawberry weevil, St. Paul, Minnesota (S. Marcovitch). The scutellum is simple.

Cirrospilopsis fuscipennis new species.

Female: Length, 1.00 mm.

Orange yellow, the abdomen dusky but the incisions of the segments showing through as dull yellow; meson of propodeum and last two pairs of tibiæ, blackish. Fore wings hyaline but with a conspicuous smoky cross-stripe from the marginal vein, the apical margin of which slopes distad from the apex of the stigmal vein for a length about equal to that vein, then slopes back, thus a cone; its proximal margin is nearly straight and a little distad of the origin of the marginal vein. Venation dusky yellow, the marginal vein nearly as long as the submarginal, over thrice the length of the rather long stigmal, the latter a third longer than the postmarginal. Marginal cilia of the fore wing distinctly longer than usual, about somewhat longer than a fourth the greatest wing width. Marginal vein with long bristles. Mandibles 5-dentate. Pedicel a half longer than wide at apex, longer than either funicle joint of which 2 is subglobular, 1 somewhat longer than wide. Terminal nipple of club small, distinct. Caudal wings where broadest with about eight lines of discal cilia. Head and thorax finely reticulated. Propodeum with a median carina and no others. Club rather large. Abdomen longer than the thorax. Fourth joint of the tarsi black.

Described from one female captured September 11, 1915, by sweeping meadows at Glenndale, Prince George County, Maryland.

Type: Catalogue No. 19931, U. S. N. M., the above specimen on a tag, the head, a hind leg and the fore wing on a slide.

Uscanopsis new genus.

Female: In my table to the *Ophioneurini* runs to *Uscanoidea* Girault but differs from that genus in bearing two ring-joints in the antennæ and both the marginal and stigmal veins are distinctly longer, the stigmal vein with a distinct, rather slender neck, the oblique line of cilia from the stigmal vein is present (not isolated but limiting the discal ciliation proximad). Marginal vein somewhat over half the length of the submarginal. Club conic-ovate, with rather long, scraggly hairs, its second joint much the longest, joint 1 much wider than long. Caudal wings short and broad, with three lines of discal cilia, the fainter one caudad, the others paired. Male the same but the club shorter. Discal ciliation of fore wing normal, that is, not in regular lines, not so dense as in *Tumidifemur*. Tarsal joints short. Cephalic tibial spur minute, straight, the caudal one elongate, three-fourths the length of the tarsus. Club articulation not very distinct. Otherwise as in the named genus.

Uscanopsis carlylei new species. Genotype.

Female: Length, 0.60 mm.

Black, the head and thorax (except a cuneate marking from cephalic margin of scutum to distal fourth and the disk of the parapsides) orange yellow, the fore wings infuscated lightly from the bend of the sub-

marginal vein distad indeterminately a little beyond the venation, the latter dusky. Legs dusky except articulations, tips of tibiæ (more broadly in the cephalic ones) and the tarsi. Club two and a third times longer than wide at base, terminating in a pair of the rather long setæ. Marginal cilia of the fore wing short but not extremely so, distinct, the fore wing shaped about as in *Trichogramma*. Mandibles equally tridentate. Body as in *Pterygogramma*. Middle tibial spur slender, slightly less than half the tarsal length, the caudal one rather stout. Male the same, the abdomen more blunt at apex.

Described one male, five females on a slide labelled "53-42. Reared from egg-mass of *Membracis tectigera*. Port of Spain, British West Indies, March, 1915, F. W. Urich."

Types: Catalogue No. 19932, U. S. N. M., the above specimens on a slide. A second slide with fragments retained as paratypes.

Oligosita oophagus new species.

Female: Length, 0.70 mm.

Bright golden yellow, the eyes darker, last tarsal joint black, the metapleurem with a longer than wide, oblique black spot. Differs from *americana* in that the funicle joint is distinctly longer than wide, the fore wings broader and with more discal ciliation, the pedicel more slender and so on. From *comosipennis* in that the fore wings are not so broad, the color much lighter, the pedicel a little more slender. The male differs in bearing a broad black band across the abdomen just distad of the middle. Distal edge of fore wing embrowned.

Described from six males, twelve females reared from an egg-mass of a leaf-hopper embedded in a leaf of sugar cane, Diego Martin, British West Indies, January, 1914 (F. W. Urich).

Types: Catalogue No. 19933, U. S. N. M., two males, four females on a slide. Six females on another slide, the same number, as paratypes.

Oligosita comosipennis in Girault, 1914 (Canadian Entomologist, p. 328) is no doubt this new species.

Achrysocharis partifuscipennis new species.

Female: Length, 0.55 mm.

Dark metallic green, the abdomen black, the legs white except caudal coxæ and bases of the other coxæ; scape pale along about its proximal half. Fore wings hyaline, with a distinct yet faint cross-stripe from the whole of the marginal and stigmal veins, the venation dusky yellowish, the postmarginal vein shorter than the stigmal. Mandibles tridentate. Caudal wings with about five lines of discal cilia where broadest. Head and thorax uniformly scaly, the propodeum smoother, with no median nor lateral carinæ. Parapsidal furrows complete.

Marginal fringes of the fore wing of moderate length, the longest about a third of the greatest wing width, the discal cilia of the fore wing limited proximo-caudad by a regular line of cilia. Pedicel a half longer than its greatest width (before apex), subequal in length and width to funicle 1; rest of flagellum slenderer, filiform-acuminate. Funicle 2 twice longer than wide, longer than club 1, subequal to club 2, club 3 longest of the flagellum, acuminate, three and a half times longer than its greatest width (not far from base) and terminating in a long, distinct spine which is about half of its length. Fore wings obtusely rounded at apex, moderate to narrow.

Differs from *Achrysocharella americana* (types compared) in having the more slender, tapering flagellum, the darker scape, smaller mandibular teeth, infuscated wings and so forth.

Described from one female captured by sweeping meadows at (Hillmead) Glenndale, Prince George County, Maryland, September 11, 1915.

Type: Catalogue No. 19934, U. S. N. M., the above specimen on a slide.

Epitetrastichus marylandensis new species.

Female: Length, 1.65 mm.

Orange yellow, the abdomen and legs yellowish brown, the following black portions: Face of pronotum centrally, flagellum and five pairs of cross-stripes on the abdomen, the second stripe of each pair abbreviated except the distal pair which is a little distance before apex. Second stripe of first pair much abbreviated, merely a transverse dash across meson, that of the fourth pair longer than that of 2 and 3 and projected a little proximad at the meson; that of pair 2 joined along the meson to the first stripe of pair 3. Ovipositor valves black. First pair of cross-stripes near base. Meson and cephalic margin of propodeum dark brown, the propodeum very short at the meson, with a carina there but no others. A line of short, black setæ across caudal margin of pronotum and lateral margin of the scutum. Apex (cephalad) of axillæ a little dusky, otherwise about as in *cuneiformis* (in death, the dorsal abdomen of the latter appears black except at base and just before apex; its propodeum is longer at the meson but not long). Distal half of scape dusky. Terminal nipple of club minute, smaller than with *cuneiformis*. Mandibles tridentate.

Described from one female captured by sweeping meadows at Glenndale, Prince George County, Maryland, September 11, 1915.

Type: Catalogue No. 19935, U. S. N. M., the above specimen on a tag, the head on a slide.

Aprostocetus whitmani new species.

Female: Length, 2.00 mm.

Very dark metallic purple, the wings hyaline; scape, a little less than the proximal fourth of the abdomen (except along the latero-dorsal margin rather broadly) and the legs except all coxæ and first two pairs of femora (except at tip). Venation pale. Scape stout, its short bulb purple; pedicel a little longer than wide at apex, a little longer than club 3. Ring-joint large. Funicles 2 and 3 subequal, each twice longer than wide, stout, 1 somewhat shorter, longer than the pedicel. Club 3 with a distinct terminal nipple; club 1 a little shorter than funicle 1, longest of the club by a little. Mandibles tridentate. Sculpture usual; a line of rather obscure punctures along the lateral margin of the scutum. Propodeum and abdomen densely finely scaly, the former longer laterad, with a distinct median carina and a very delicate, short, curved lateral one from caudad (half or less complete). Cephalic femora more broadly white at tip. Pedicel whitish, purple above at base. No postmarginal vein, the stigmal moderately long. Abdomen conic-ovate, pointed, somewhat longer than the rest of the body. Fore wings broad.

The male is the same but the abdomen is oval, flat and short, the scape compressed and dilated (uniformly, nearly, for its entire length), purple above and below, the funicle is white, also the club except the distal joint. Also, the cephalic femur is purple only dorsad centrally and the middle one only centrally. The funicle is 4-jointed, the club 3-jointed and as in the female except the middle joint is longest. Funicles 1–2 subequal, a half longer than wide, 2–3 subequal, each nearly twice longer than wide. Club 2 subequal to funicle 2.

Described from one male, eight females, reared from the eggs of *Physonota unipunctata*, St. Paul, Minnesota (S. Marcovitch).

Types: Catalogue No. 19936, U. S. N. M., the above specimens on three tags plus a slide bearing a male and female head.

Rhopalicus americanus new species.

Female: Length, 3.00 mm.

Bright metallic green, the legs, scape and pedicel reddish yellow tinged centrally with brownish, the venation yellow, the fore wings with a large fuscous blotch from the whole of the marginal vein, this blotch oblique, rectangular (longer than wide, its sides parallel, its apex reaching slightly beyond the middle of the wing and fainter). Head and thorax very finely punctate, the clypeus bidentate at apex. Antennæ inserted slightly below the middle of the face, 13-jointed with two ring-joints (the second the larger), the club short, ovate; funicle 1 a half longer than wide, subequal to the pedicel, 2 a little shorter than it, 3 and 4 subequal, each slightly longer than wide, the rest quadrate.

Marginal vein subequal to the elongate stigmal, somewhat shorter than the postmarginal. Cephalic femora but moderately swollen. Parapsidal furrows just indicated cephalad. Propodeum of moderate length, with a median carina and no others except short rugæ from its cephalic margin; no spiracular sulcus. Cephalic coxa metallic at base laterad, hind coxæ all metallic. Propodeum without a neck, its caudal margin rimmed. Abdomen produced beneath, conic-ovate. Mandibles tridentate.

Described from one female in the U. S. N. M., "Agricultural College, Michigan, 7-26-1890."

Type: Catalogue No. 19937, U. S. N. M., the above female plus a slide bearing a head, a hind leg and a fore wing.

Coccophagus cinguliventris Girault.

Male: In the male the yellow band on the abdomen is very short, subobscure; the head and thorax more brownish. One male, two females reared from *Lecanium corni* at Madison, Wisconsin, June 22, 1915. (F. A. Fenton.)

ARTHOLYTIS APATELÆ and **A. PIMPLÆ** Ashmead are synonyms. The median carina of the propodeum is delicate. There is a round fovea at cephalic margin of propodeum at mesal base of the delicate lateral carina. The propodeal spircale is round, small. The second ring-joint is larger than the first; funicle joints widening distad, 6 largest, all wider than long and much shorter than the pedicel.

Gonatocerus triguttatus new species.

Female: Length, 0.85 mm. The ovipositor slightly extruded.

Dull honey yellow, the wings hyaline, the following parts black: Ocellar area, dorsal and ventral edges of the scape, flagellum, marginal and stigmal veins, abdomen, three round spots on thorax, the mesal one between the axillæ and ends of the parapsidal furrows (not on the scutum), the lateral ones on the axillæ cephalad and laterad. Tibiæ darker than the rest of the legs, but not much more so. Scape considerably but not greatly convexly dilated ventrad. Pedicel short, only slightly longer than wide, shorter than funicle 1 which is subequal to 2 and longest (or slightly shorter than 2 which is thrice longer than wide); funicle 3 subequal to 1, the others shortening in succession, 8 slightly longer than wide. Fore wings of moderate width, their marginal cilia moderately short, about an eighth of the greatest wing width. Head and thorax glabrous. Scutum with an embrowned triangular scalelike area on each side of the meson cephalad. Propodeum with a pair of delicate median carinæ, widely separated and a distinct, curved "lateral carina" which originates caudo-laterad of the minute spiracle. Scutellum separated from the scutum by a transverse sclerite which runs caudad of the axillæ and is longer than the postscutellum. Caudal wings narrow.

The male the same but the three spots on middle thorax are more or less connected transversely (they are in a line in both sexes), the scutellum is all black except its margin all around, the scutum is entirely black and on each parapside there is an exclamation-point-shaped marking at cephalic margin, this transverse and with the thickened end laterad (sometimes present in the female). The abdomen is yellow, striped with black. Scape very short, the pedicel extremely so; funicle joints lengthening distad, the longest about thrice longer than wide; club joint distinctly longer than funicle 1.

Described from one male, seven females reared from an egg-mass of a leaf hopper on orange, Caroni, British West Indies, February, 1913 (F. W. Urich).

Types: Catalogue No. 19938, U. S. N. M., the above specimens on tags.

Habrocytus quinquefasciatus new species.

Female: Length, 3.25 mm.

Dark metallic green, the propodeum bright green, the wings hyaline, the venation, abdomen, pedicel and basal half of funicle 1, reddish yellow; legs and scape light yellow. Abdomen with five distinct metallic blackish cross-stripes, the first thinnest, at apex of segment 2, 5 at apex, 4 as long as 5 and apparently across the middle of segment 6, 3 mostly on the basal four-fifths of segment 5. Tip of ovipositor valves black. Mandibles 3- and 4-dentate. Head and thorax finely punctate, the clypeus striate, incised medially. Segment 2 of abdomen occupying nearly a third of the surface, smooth, rest of abdomen finely scaly along cephalic margin of the segments; a little scaliness on segment 2. Scutellum without an obtuse cross-carina. Propodeum with a distinct median carina, no lateral one but there is an obscure cross-carina from the median one cephalad to the spiracle and short longitudinal carinæ from the cephalic margin to this and dividing foveæ (extending for a little over half way to the spiracle from the meson). Also on the short neck there are short carinæ. Spiracle of propodeum longer than wide; of moderate size. Antennæ inserted below the middle of the face yet slightly above the ventral ends of the eyes, 13-jointed with two ring-joints; funicle 1 elongate, widening distad, over twice longer than wide at apex, distinctly longer than the rather long pedicel which is twice longer than wide, slender, 6 wider than long, 4 quadrate; second ring-joint twice the length of the first. A marginal spot on the abdomen a little distad of middle of segment 2. Parapsidal furrows about two-thirds complete, not deep. Marginal vein slightly longer than the elongate stigmal, the latter a little shorter than the postmarginal.

The male is the same but the abdomen has a broad white stripe across it some little distance out from base (longer than the basal black and extending a little beyond segment 2, the latter longer than in the female) followed by a cross-stripe of black which is narrow and

divided along the meson, then by a second, very narrow white stripe, thence black. The obscure cross-carina on propodeum here absent. Antennæ with the pedicel slightly longer than wide.

Described from a single pair labelled "3816°1, March 6, 1886." Eastern United States.

Types: Catalogue No. 19939, U. S. N. M., the pair on a tag plus a slide bearing a female head, fore wing and hind tibiæ and a male antenna.

Anastatus aureicorpus new species.

Female: Length, 4.00 mm., excluding the ovipositor, which is extruded for a length equal to a half that of the abdomen.

Reddish brown or orange, the club black, the scutum between the lateral ridges and caudad of the cephalic triangular piece, dark metallic purple; ovipositor valves soiled yellowish (but most of apical part missing). Fore wings with a reddish brown stripe across them from the bend of the submarginal vein to apex of stigmal, this stripe fading near caudal margin. Funicle 1 quadrate, 2 subequal to the pedicel, longest, thrice longer than wide, 3 and 4 subequal, each slightly shorter than 2; 8 slightly longer than wide, larger than 2. Club short, obliquely truncate from base of joint 3. Ocelli in small metallic spots. Caudal coxæ and funicles 1–3 darker. Postmarginal vein short, slightly longer than the stigmal. Raised triangular piece of the scutum and the somewhat separated axillæ more coarsely scaly than the rest of the body, the scutellum with scattered, short black setæ. Face above the antennæ with grayish, stiffish pubescence (longer along the eyes). Segments of abdomen with straight caudal margins. Abdomen as long as the thorax.

Described from one female on a tag labelled "Austin, Texas, Carl Hartman" and reared from what appears to be a syrphid puparium.

Type: Catalogue No. 19940, U. S. N. M., the above specimen on a tag.

Abbella subflava Girault.

Five females reared as hyperparasites of *Polynema cutelleri*, from beet leaf-stems, August 28, 1915, Spreckels, California. The cheeks and sides of the thorax were dusky; otherwise like the types and probably a variety.

Crataepus fletcheri Ashmead.

As described. Cephalic tibiæ with a strong, black, bifurcate tibial spur. Antennæ short; scape like a rather long pedicel, the latter somewhat shorter than the scape, slightly longer than wide at apex; funicle joints all hemispherical and wider than long, 1 largest, 2 and 3 subequal; club 3-jointed, not as long as the funicle, its first joint half, its last joint

small, distinct, with three minute, acute nipples at apex. Three ring-joints of which the middle is largest, distinct. Postmarginal vein absent, the stigmal long. Scutum with a median groove, flat, the scutellum with four. Pronotum flat, *large*. Antennæ 11-jointed, the funicle and club each 3-jointed.

From the type in the U. S. N. M. (a fore leg and antenna on a slide).

Ceranisus flavopictus Ashmead.

The types are unrecognizably mutilated but the female scape (the only part of the antennae present) shows no dilation and the marginal fringes of the fore wing are short and usual. The color appears to be wholly black. The species is hopeless.

Sympiesomorphelleus whitmani new species.

Female: Length, 1.85 mm.

Reddish brown, the wings hyaline, the abdomen and legs (also scape) yellowish brown; the following black parts: Center of occiput, ocellar area, flagellum and apex of the scape, pronotum (except the neck), cephalic fourth of scutum (except along the meson narrowly), axillæ, scutellum laterad of the groove, propodeum lightly distad (its well-defined neck) and along the meson and the margins of the abdomen from base to about middle (but broken in two places). Also the post-scutellum and a narrow line from the spiracle on the propodeum. Median carina of the propodeum forming an X whose distal arms are very long, the carinæ joining not far distad of their origin; no lateral carina. One spur of hind tibiæ small. Mandibles 7-dentate. Pedicel somewhat longer than wide, shorter than any funicle joint; funicles 1–3 subequal, each about thrice longer than wide, 4 slightly shorter, club joints about equal in length, 1 about twice longer than wide, 2 terminating in an acute, spinelike point. Flagellum filiform. Thorax scaly reticulated. Grooves of scutellum practically joined around the apex. Postmarginal vein much longer than the stigmal, the marginal long.

Described from a female in the U. S. N. M., labelled "174. Gifu, Japan, Y. Nawa Collection."

Type: Catalogue No. 19941, U. S. N. M., the above specimen on a tag, the head and hind legs on a slide.

Cheiloneurus albicornis Howard.

Differs from the original description of *albicornis* Howard as follows: The middle tibiæ are purple except at tip and a silvery area just before base; the caudal femur interiorly has a middle silvery streak along its distal half or more (in some specimens); in some specimens the middle tibia is silvery along its distal half. The scape is distinctly dilated but not greatly.

The male is wholly blue, the wings hyaline, the legs except the last tarsal joints and most of the caudal tibiæ and the antennæ except scape and pedicel, pale yellow. Club solid, the flagellum clothed with whorls of long hairs. Pedicel very short. In the type female, the middle tibia is dark just below the knee.

One male, seven females reared from *Pulvinaria* spp. on Poison Ivy, Madison, Wisconsin and from *Physokermes piceæ* on *Picea abies*. The mandibles in all specimens were as in *Cristatithorax*.

In the male, funicles 1 and 6 are longest, nearly thrice longer than wide, shorter than the club; funicles 2 and 3 subequal, shortest, the joints widest a little out from the base. Club five times longer than wide, or more.

Ooctonus quadricarinatus new species.

Male: Length, 1.30 mm.

Propodeum with a pair of median carinæ which diverge widely to middle, then converge to apex, forming a large diamond; its caudal and cephalic margins carinated; and a strong lateral carina which from cephalad runs meso-caudad for over half way, joining (or nearly) the lateral angulation of the diamond of the median carinæ, thence for a short distance latero-caudad to apex; this shorter arm forms therefore a rather small, distinct diamond-shaped areola. Lateral margin also strongly carinated and between this and the minute spiracle runs a long, oblique, smooth groove. Propodeum and postscutellum glabrous; rest of thorax strongly scaly. Scutellum divided by a semi-circular cross-suture whose apex is proximad of the middle, the convexity facing cephalad. Lateral margin of postscutellum carinated. Head finely scaly. Abdominal petiole long, somewhat longer than the caudal coxæ. Black, the wings hyaline, their venation black; tarsi, knees, tips of tibiæ rather broadly and scape and pedicel, more or less reddish brown. Characterized by the very broad fore wings which are subtruncate at apex and bear about 38 lines of very fine discal cilia where widest, the longest marginal cilia not a tenth of the greatest wing width. Caudal wings with 4–5 lines of discal cilia. Pedicel a little longer than wide; funicle joints six or more times longer than wide, the club shorter but somewhat longer than funicle 1. Proximal tarsal joint much the longest. Venation elongate.

Described from three males reared in connection with bark beetles (from limbs of pine infested with *Pityogenes hopkinsi*) August 16, 1915, New York. The locality is Syracuse.

Types: Catalogue No. 19942, U. S. N. M., the above specimens on a slide.

Anicetus chinensis new species.

Female: Length, 2.00 mm. Ovipositor extruded a short distance.

Differs from the genotype in being larger, in being deep orange in color with the disk of the abdomen and a broad line down propodeum between the spiracle and meson, deep metallic purple. The antennæ are purple suffused with yellowish. Fore wings yellow from a little before the bend of the submarginal vein distad to near apex, the distal margin of this yellow flatly convexed and browner like a ring (as in the Australian *felix*). Mandibles with three distinct, equal, acute teeth. Frons subprominent, the great inflexion of the face with an acute, convex, dorsal margin. Frons moderately narrow, a little over thrice the diameter of the cephalic ocellus. Cheeks as long as the eyes. Axillæ with a carina between them. Pedicel greatly concaved and winged at apex. Differs further from *ceylonensis* in the larger pedicel. Funicle with a backbone, the joints given off as so many vertebræ, the first much narrower than the last which is as wide as the club. Marginal vein thrice longer than wide, the stigmal a little shorter than it, a fourth longer than the postmarginal. Frons with several rows of shallow punctures (caudo-cephalad). Pronotum transverse, the middle of its cephalic face purple. Head and thorax very finely sculptured, giving a velvety sheen. Margin of abdomen at base purple. Thorax with scattered, obscure setigerous punctures. External valves of ovipositor purplish. Tibiæ setose. Hairless line of fore wing with many lines of cilia proximad of it. Caudal wings broad (about 25 lines of rather fine discal cilia). There is a dusky line across the face as in *felix* and the genotype.

Described from one female on a tag from China and reared from a Lecanium (Compere).

Type: Catalogue No. 19943, U. S. N. M., the above specimen plus a slide bearing the head and a pair of wings.

The genotype has the club obliquely truncate from the base of the third joint and the scape is edged with black ventrad; the marginal vein is about twice longer than wide, somewhat shorter than the stigmal. The mandibles were missing in the single specimen. The caudal wings are hyaline excepting for a long-ovate, fuscous spot just under the apex of the venation; they bear about 22 lines of discal cilia where broadest.

The genus *Habrolepopterygis* Girault is a synonym of *Anicetus*.

Sympiesomorphelleus bicoloriceps new species.

Female: Length, 2.25 mm.

Lemon yellow, the wings hyaline, the body marked with black as follows: Upper half or more of head except a flat triangular area on vertex against the eye, a median stripe up the occiput (upper part) to vertex, cheek right under apex of the eye and a spot on face against the

eye; a rather broad, oblique stripe down propodeum through the spiracle (forming a V but the letter not quite joined at apex); ovipositor valves, a spot on each side of meson of abdomen at apex and a long-obovate stripe from base down meson of the abdomen to distal sixth (widest at about the middle of the abdomen). Flagellum and distal third of hind tibiæ fuscous. Caudal spurs long, stout. Pedicel barely longer than wide; funicle 1 twice longer than wide, longest, 4 a half longer than wide, somewhat longer than club 1; terminal nipple of club subobsolete, its joint longer than the pedicel. Postmarginal vein twice the length of the stigmal, about a half the length of the marginal. Pronotum, scutum, parapsides and dorsal abdomen (except distal edges of segments) distad of segment 2 rather coarsely reticulated, the scutellum glabrous and so the rest of the thorax. Propodeum with a pair of delicate median carina which diverge at *base* (cephalad) and no true lateral carina, the spiracles reniform. Groove of scutellum just mesad of the two bristles on that side of the scutellum. Segments 2 of abdomen occupying a fourth of the surface. Head and cephalic thorax with scattered, rather long hairs. Antennæ inserted just above the ventral ends of the eyes.

Described from two females on tags in the U. S. N. M., labelled "From *Tinea* on *Solanum*, August 11, 1886, C. V. Riley."

Types: Catalogue No. 19944, U. S. N. M., the above specimens and a slide bearing a fore wing, hind tibiæ and antennæ.

Miotropis platynotæ Howard.

This is a species of *Sympiesomorphelleus*. Propodeum with a delicate paired median carina and a curved lateral one. Scutellum distinctly scaly but not as coarsely as the scutum. Brown margins of the abdomen indefinite, the dusky spot of the disk also, often absent. Mandibles 8-dentate. Funicle 1 twice longer than wide, 4 a fourth shorter. Terminal spine of club distinct but not large. Pedicel shorter than funicle 4. From the female types (hind tibiæ and head mounted on a slide).

Stigmatotrastichus new genus of the Ceratoneurini.

Female: Head flattened or very thin, concaved, longer than wide, the antennæ inserted below the middle of the face yet above the ventral ends of the eyes, the vertex elevated. Pronotum large, conical, as long as the peltate scutum, the latter simple. Scutellum with four delicate grooves; abdomen with a distinct, quadrate petiole, flattened above, not so long as the thorax. Propodeum large, with a delicate median carina and apparently a weak lateral carina directly from the spiracle. Marginal vein long, as long as the submarginal and distinctly, conically thickened at base, the thickened part black and conical, a third of the length of the entire vein. Postmarginal vein distinct, short, not quite half the length of the stigmal which is about a fifth the length of the marginal. Marginal cilia of the fore wing a little longer than usual.

With the habitus of a Pirenine, Tetracampine or *Spalangia*. Caudal tibial spur single, small. Proximal tarsal joint longest of the four. Sculpture very fine, usual for the group. Coxæ elongate. Antennæ 10-jointed with two ring-joints.

Stigmatotrastichus emersoni new species. Genotype.

Female: Length, about 0.90 mm. Very dark æneous black, the scape, the pedicel except above, coxæ, tarsi except the last joint, tips of tibiæ, proximal third of caudal tibiæ (and very much less of the other tibiæ) and the abdominal petiole, white. Fore wings embrowned (most deeply under the marginal vein) but clear under distal three-fourths of the submarginal vein and with a hyaline, subnaked cross-stripe (abbreviated caudad) from the apex of the postmarginal vein (crossing the stigmal). Pedicel elongate, over twice longer than wide, a little over half the length of the scape. Funicle 1 subequal to the pedicel, 2 much shorter, somewhat longer than wide, 3 subquadrate, as long as club 3 (the longest of the club) which ends in an acute, nipple-like point. Bulb of scape black. Ring-joints sub-equal, distinct.

Described from a female on a tag in the U. S. N. M., labelled "*Paraspalangia annulipes* Ashmead, female type. Type No. 12731, U. S. N. M. College Station, Texas, Banks, September."

Type: Catalogue No. 12731, U. S. N. M., the foredescribed female and a slide bearing an antenna, a fore wing and the caudal legs.

Paraspalangia Ashmead was proposed as a new genus in the Spalangiinæ but no species was ever described though one was named as above.

Parecrizotes new genus.

Female: In Ashmead's table to the Pireninæ runs to *Ecrizotes* Foerster but differs from that genus in having the marginal vein distinctly thickened at base, the thickening conical distad and occupying about half of the length of the vein which is somewhat less than twice the length of the well-developed, curved stigmal, the latter a little shorter than the postmarginal. Ovipositor valves extruded for a length about half that of the abdomen, the latter conical and a little longer than the rest of the thorax. Parapsidal furrows complete, deep, Scutellum simple. Propodeum very short at the meson, lengthening laterad, practically noncarinate. Pronotum subtransverse-quadrate. Strigil strong, also the caudal tibial spurs, the latter unequal, not enlarged especially. Legs moderate. Head wider than the thorax, the vertex wide, the antennæ inserted near the clypeus, 11-jointed with one-minute ring-joint, the five funicle joints enlarging distad, the wider, large-ovate club nearly as long as the funicle. Mandibles palmately 4-dentate. Maxillary palpi 4-jointed. Scutellum with a lateral groove like the *second* one of the *Tetrastichini*. Head somewhat longer than wide.

The male differs in having the antennæ filiform, 12-jointed with two minute ring-joints, the funicle 6-jointed, the club 2-jointed and terminating in an obtuse nipple; funicle and club joints clothed with long soft hairs, more or less 2-whorled (less numerous in the female).

Parecrizotes marylandensis new species. Genotype.

Female: Length, 1.00 mm.

Lustrous black, the head and thorax distinctly scaly; cephalic knees, proximal one or two tarsal joints, a band at base of caudal tibia and apex of scape, silvery white. Wings hyaline, the venation dusky pallid, the swelling of the marginal vein black. Mandibles reddish yellow at apex, the teeth decreasing in size from the first, acute. Pedicel a little longer than wide, slightly larger than funicle 5 which is a little wider than long; funicles 1–3 like large ring-joints but much larger than the real ring-joint; 4 not much smaller than 5. Club without a terminal nipple.

The male differs in having the entire scape black; funicle 1 is largest, cup-shaped, 4–6 twice wider than long. Club nearly equally divided. Last joint of maxillary palpus elongate, equal to the other three taken together.

Described from one male, three females captured by sweeping meadows, September 28, 1915, at Hillmead, Prince George County, Maryland. A rather common species. There is a pair in the U. S. N. M., labelled "*Henicetrus annulipes* Ashmead, Virginia, October 10, 1880," and a female labelled "*virginiensis* Ashmead, Arlington, Va., June 1884."

Types: Catalogue No. 19945, U. S. N. M., a female on a tag plus a slide bearing a pair, a male and female head and female caudal tibiæ. The types were collected in the Maryland locality.

Roptrocerus rectus Provancher.

A number of specimens of both sexes, Ithaca, New York, reared in connection with *Ips pini*, July. There is considerable variation in color; the antennæ may be reddish brown nearly to the club, the ovipositor all black, the legs all yellow brown except the coxæ. The caudal legs are usually metallic, the caudal tibiæ with a broad yellow band just below the knee.

The male is much smaller and has a rather narrow yellow stripe across the abdomen very near base; its antennæ are filiform, 13-jointed with *two* ring-joints; funicle 1 is about twice longer than wide, longest of the flagellum while 6 is a half longer than wide or nearly, longer than the short pedicel. Otherwise about as in the female. The marginal vein in both sexes is thicker proximad, somewhat as in *Muscidifurax* but not so noticeably. A female from Michigan bore no carinæ on the propodeum.

An unstable, widely distributed species probably introduced from Europe.

Achrysocharella obscurinotata new species.

Female: Length, about 0.90 mm.

Bright golden yellow, the wings hyaline, the antennæ black except proximal three-fourths of the scape dorsad; the other portion of the scape and the pedicel dusky, the latter yellowish at apex. Valves of the ovipositor extruded slightly, black. Abdomen above with four small transverse dusky spots, along each side of the meson (thus four pairs or eight in all), the first smallest, some little distance out from base, the fourth at about middle and widest apart from its reciprocal, about twice wider than long, 1 barely wider than long, absent in one specimen. Scutellum with two black bristles distad, the scutum with four in a rectangle, the caudal two longest. Mandibles with three spreading teeth, long, pale, reddish at apex. Postmarginal vein subequal in length to the stigmal. Propodeum noncarinate. Pedicel nearly a half longer than wide, subequal to funicle 2, funicle 1 nearly twice longer than wide; club joints nearly equal, each a little shorter than the funicle 2, club 3 with a distinct terminal nipple which is not half of its length. Flagellum with long, scattered hairs, some stout, mostly very slender. Head and thorax scaly. Parapsidal furrows incomplete.

Described from two females captured by sweeping *Solidago*, Eupatoria and so forth, September 27, 1915, at Hillmead, Glenndale, Prince George County, Maryland.

Types: Catalogue No. 19946, U. S. N. M., the above specimens on tags, the two heads on a slide.

Eupelminus coleopterophagus new species.

Female: Length, 2.50 mm., excluding the ovipositor which is extruded a fourth the length of the abdomen and is white centrally.

Differs from *meteori* Gahan in having most of the thorax metallic; from *dryorhizoxenii* Ashmead about the same; the body is slenderer than with either of these species; from an identified female of *epicaste* Walker in having the ovipositor somewhat shorter, the scutum entirely metallic mesad, the legs lighter in places, the pedicel longer.

Subapterous, the distal half of the small wings fuscous. Metallic green, the abdomen dark purple, encircled at base by a broad silvery band. The following parts reddish yellow: Scape, axillæ, basal third of scutellum, lateral ridges of the scutum, propleurum, proventer cephalad, mesopleurum cephalad, tarsi, cephalic femora and tibiæ interiorly, tips of tibiæ and middle femora except above. White part of valves of the ovipositor somewhat longer than either black part, the latter short. Scutum without a median ridge. Funicle 1 somewhat wider than long, 3 and 4 longest, subequal to each other and to the pedicel, 2 twice longer than wide, a little shorter than 3, 7 quadrate, 8 slightly wider

than long. Scape not compressed. Axillæ a little separated. Head and thorax scaly, Scutellum plane. No raised area mesad on cephalic scutum. Segments of abdomen caudad excised slightly at the meson.

Described from four females reared in connection with the strawberry weevil, St. Paul, Minnesota (S. Marcovitch).

Types: Catalogue No. 19947, U. S. N. M., the above specimens on two tags, a head on a slide.

Eupelmus neomexicanus new species.

Female: Length, 2.60 mm., the ovipositor just projecting beyond the tip of the abdomen, white.

Dark metallic green, the wings hyaline; legs, prepectus, mesopleurum and a moderately broad stripe across the abdomen just out from base but more or less distinct, reddish yellow. Venation pale yellowish. Tarsi white, the last joint dusky. Tip of caudal tibiæ, white. Postmarginal and stigmal veins subequal. Antennæ black, the scape not noticeably compressed; funicle 1 somewhat longer than wide, 3 and 4 longest, subequal, neither as long as the pedicel which is over 2½ times longer than wide at apex; funicle 2 a third longer than wide, 3 twice longer than wide; 8 slightly wider than long. Head and thorax finely scaly, the axillæ and scutellum uniformly coarser. Abdomen scaly like the scutum, the latter with a lateral ridge but no median (or else it is very obscure and delicate). Raised, triangular part of the scutum cephalad not with a different sculpture. Segment 2 of abdomen deeply incised at meson of its caudal margin, the following segments less and less so.

Described from two females in the U. S. N. M., labelled "Las Cruces, New Mexico."

Types: Catalogue No. 19948, U. S. N. M., the above specimens on tags plus a slide with fore wings and antennæ.

Hemænasoidea new genus.

Female: In my table of the earth's encyrtine genera runs to *Hemænasius* Ashmead but differs from that genus in having the head much longer than wide, the eyes very long, six times longer than the distinct yet short cheeks, the head lenticular, the frons moderately narrow. Mandibles with three acute teeth, the first two equal, the third short. Ovipositor extruded nearly half the length of the abdomen. Marginal vein slightly longer than wide; the postmarginal moderately long but somewhat shorter than the stigmal. Hairless line of fore wing narrow. Axillæ barely separated.

Hemænasoidea oculata new species.

Female: Length, about 1.75 mm., excluding the ovipositor.

Dull honey yellow, the following embrowned parts: Center of cephalic pronotum, scutum, abdomen, tip of ovipositor valves, tibiæ except at ends (caudal tibiæ much darker, purplish), scape, pedicel and funicles 1–2. Fore wings embrowned at base and from the bend of the submarginal vein distad to about a point as far distad of the apex of the stigmal vein as that vein is long; this central infuscation is followed by a discal (longer than wide) naked area inclosed by discal cilia; otherwise the fore wing very finely ciliate discally but naked between the two infuscations. Venation dusky yellow, Scape reaching to the cephalic ocellus, cylindrical, the pedicel two and a half times longer than wide at apex, longer than any funicle joint; funicle 1 longest, a half longer than wide, 5 slightly longer than wide, 6 quadrate. Club about half the length of the funicle, obliquely truncate, not enlarged. Body finely scaly. Scutellum with a few scattered, rather coarse hairs. Pronotum moderately large. Axillæ large. Legs slender. Middle femora, tarsi (except last joint), ovipositor valves (except at apex) and antennæ distad, whitish. Club truncate from base of joint 1.

Described from a female on a slide in the U. S. N. M., labelled "Reared from *Pseudococcus citri* on bamboo, Manila, Compere, July, 1909. No. 24.

Type: Catalogue No. 19949, U. S. N. M., the above specimen on a slide.

OBSERVATIONS ON THE LIFE HISTORY OF PTERODONTIA FLAVIPES GRAY. (DIPTERA.)*

By J. L. KING, Wooster, Ohio.

INTRODUCTION.

During the summer of 1915, while at Gypsum in northern Ohio, the writer found several peculiar dipterous larvæ under burlap bands which had been placed around the trunks of some apple trees. The adults reared from these proved to belong to the genus Pterodontia of the family Cyrtidæ. From the literature at hand it was evident that little had been published concerning the habits of this interesting family. This stimulated further observation, the results of which are recorded in this paper. Later a more thorough study of the literature was made, particularly of those articles which deal with the life histories of the members of the family. These have been briefly summarized and are appended after each special topic.

The writer wishes to express his gratitude to Professor A. D. MacGillivray for his kind interest and help in the preparation of this paper. Thanks are also due to Mr. J. R. Malloch, of the Illinois State Laboratory of Natural History for the identification of the species, and to Mr. Nathan Banks for the determination of the host spiders.

THE MATURE LARVA OF PTERODONTIA.

On July 20, 1915, three larvæ were found under the burlap bands which surrounded the trunks of some large apple trees. In all cases the larvæ were found either suspended in abandoned spider webs or entangled by threads and resting partly on the bark or on the burlap. When suspended, their position was maintained by the web adhering to their sticky body surface. In two cases the remains of spiders were found near the larvæ. The largest larva, measuring 8 mm. in length, had emerged from the abdomen of an Epeirid spider, *Epeira sericata* Clerk, leaving the abdomen through a comparatively small hole on the ventral side, in the region of the anterior lung-slit. From

*Contribution from the Entomological Laboratories of the University of Illinois, No. 49, and the Ohio Experiment Station, Wooster, Ohio.

the size of the larva and the scant remains of the abdomen, it would seem that the larva had almost filled the entire abdomen. The cephalothorax and legs were also eaten out so that the remains resembled a cast skin, except for the fact that the cephalothorax was not broken. The smallest larva, which was 6 mm. in length, had emerged under similar conditions but from a smaller spider. In the third case no remains of a spider were noted.

Since the foregoing notes were written, five larvæ of this species have been found to be parasites of Lycosid spiders. Concerning the identity of these, Mr. Nathan Banks states that he is almost certain the species is *Lycosa pratensis* Emer., the doubt of the question being due to the partial destruction of the specimens by the parasites.

The larvæ vary in length from 6 to 8 mm. and are oval in form with a strong constriction marking off the smaller cephalic end (Fig. 8). They are of a creamy white color and on the dorso-meson show four dark areas which pulsate in a slow, rhythmic manner. The body-wall is soft and delicate, the external surface being smooth and sticky, causing the web and small particles of dirt to adhere to it. The segmentation of the body is not very distinct; however, the cast skins show twelve body segments. The four anterior segments are not as well defined as the others and seem to be softer and more delicate. The second segment bears a pair of closed spiracles which connect with large tracheal tubes. On the ventral surface of the fifth to the eleventh segments are seven pairs of padlike areas which are armed with minute crotchets. The caudal spiracles are located on the dorsal surface of the twelfth, or caudal, segment. They are larger than the anterior spiracles and have a distinct opening. In the living larva they are capable of being slightly extended or retracted.

The mouth-parts have been studied from cast larval skins. The external mouth-parts consist of two minute bidentate mandibles, and two mouth-hooks (Fig. 8a, m. and m. h.). These structures are attached on each side of the small mouth opening. The internal structure consists of a pharyngeal plate in the form of a shallow trough with two curved anterior arms which meet and form a circular loop above the mouth cavity (Fig. 8a, ph. p.). Attached to the margins of the pharyngeal plate and loop is a tough membrane which forms the dorsal

roof of the pharynx. Whether muscular attachment converts this structure into a pharyngeal pump or whether further parts are wanting cannot be determined until additional material is at hand.

LITERATURE ON THE LATE LARVAL STAGES OF THE CYRTIDÆ.

In Europe Menge (15)* in 1863 was the first to record that the Cyrtidæ are parasitic in the bodies of spiders. He obtained from the nest of a spider, *Clubiona putris*, a larva which proved to be that of *Oncodes pallipes* Erich. (*Henops marginatus*). Further examination of the nest of the spider revealed the shriveled remains of the spider with a large hole in the underside of the abdomen. Brauer (2) in 1869 described and figured the larva and pupa of *Astomella lindenii*, which were found in the burrow of a spider, *Ctenzia ariana*. According to Brauer's (3) observations, the larvæ, while lodged within the abdomen of the host, breathe by placing their caudal spiracles in one of the lung-chambers of the spider. The fully grown larva of *Astomella lindenii* is 10 mm. in length and is comparatively thick. The body has twelve segments. The head segment is small and is fitted with mandibles and maxillæ. The larva is amphipneustic, having prothoracic and caudal spiracles.

In the United States several observers have recorded the finding of Cyrtid larvæ, though they have given us no detailed descriptions of them. Among the most important of these are Emerton's (4) observations on the larvæ of *Acrocea lasciata* Wied. The larvæ were found clinging to the deserted webs of *Amaurobius sylvestris*. They were suspended in the webs, heads uppermost, clinging to it with their jaws and also supported by threads under and around them. The shriveled remains of the spiders were found in the webs. The larvæ are described as soft, white maggots from one-eighth to one-fourth of an inch in length with the hinder half of the body thicker than the front half and nearly spherical. A single figure of the larva is shown. Johnson (7) in 1903 is reported as having reared the same species from *Lycosa stoni*. He states that many spiders, perhaps twenty-five per cent, are parasitized by these flies. Montgomery (16) in 1903 records the occurrence of Cyrtid

*Numbers refer to the bibliography, page 000.

larvæ as parasitic in spiders of the genus Lycosa which he had under observation. One male and six female spiders were found to be parasitized and in one case two larvæ issued from a single spider. This observer notes that a short time before the parasite escapes from the body of its host, the spider acts in a peculiar manner, walking about spasmodically and often spinning aimlessly. After the soft parts of the body of the spider are eaten away the parasite emerges through a hole which it makes in the abdomen; this emergence kills the host. The bulk of the body of each parasite is noted as being almost equal to that of the abdomen of the host.

THE PUPA OF PTERODONTIA.

The pupation of the larvæ took place July 21, or the day after the larvæ left their hosts. The pupa (Fig. 9) was 6 mm. in length and when first formed was light creamy-white, but soon after it turned to a pale yellowish-brown color. The surface is smooth, shining, and without setæ or spines except for a prominent V-shaped crest on the head. This is composed of a large number of irregularly barbed, clublike processes (Fig. 9a). The various adult parts, as the rounded head which is quite prominent, the wings, tegulæ and legs are quite distinctly outlined in the pupa. On the cephalo-lateral aspect of the thorax there is a single pair of spiracular projections and caudad of these the thorax is elevated into a rounded hump. The abdomen consists of eight segments, the anterior three each bearing a pair of elevated spiracles. The caudal segments are telescoped into the preceding segments, giving the abdomen a truncated appearance. The lateral line caudad of the third spiracle is marked by a dark furrow. The duration of the pupal period was seven days.

LITERATURE ON THE PUPÆ OF THE CYRTIDÆ.

The pupa of *Astomella lindenii* has been described by Brauer (2). It differs from the pupa of Pterodontia in several characteristics; namely, the head is less prominent and lacks the crest of spines; the thorax bears on the dorso-meson a row of spines. The abdomen shows seven segments, the first six of which bear spiracles. The empty pupal case is dark brown spotted with light yellow.

Of the American species the pupa of *Oncodes costatus* Loew is described by Malloch (12). The description was made from a single pupal exuvium. In most respects the pupa seemed to be similar to that of Pterodontia but differs in having five spiracles; the anterior four are on prominent protuberances. The crest of barbed spines is also wanting in this species.

THE ADULT.

Female.—(Fig. 1) Head spherical and small in proportion to the thorax. Eyes contiguous, large, black, and densely clothed with long, black setæ. Ocelli three in number. Antennæ inserted ventrad of the compound eyes; they consist of three segments, the third of which bears three or four terminal setæ. The mouth-parts are obsolete. Thorax large, mesonotum piceous and shining; scutellum light yellow or sometimes light brown. Ventral parts of thorax dark brown. The entire thorax is clothed with long, black hairlike setæ. Legs pale yellow except the femora which are somewhat darker yellow or brownish. Tegulæ large and brownish in color. Wings slightly clouded, membrane undate, veins dark yellow or brown. Venation as shown in Figure 3. The toothlike projection near the distal end of the costal margin is wanting in the female. Abdomen large, globular and inflated. First abdominal segment black or brownish. Second abdominal segment yellow or testaceous and with the cephalic margin black; in some individuals this segment has a median triangular black spot. The third segment in most specimens is entirely yellow or testaceous; however, a few specimens have a median, black, triangular spot on the cephalic margin. The remaining segments are yellow or testaceous. Ventral surface of abdomen dark brown. The entire surface of the abdomen is clothed with long, black, hairlike setæ. The length varies from 4 to 8 mm. with an average of 6.5 mm. taken from a series of twenty-six females.

Male.—The male differs from the female in the following points: Thorax broad and more robust than that of the female. Four posterior femora black. Wing veins yellow, toothlike projection on the costal margin prominent (Fig. 3). Second abdominal segment shining black. Third segment testaceous and with a large median rectangular spot. Fourth segment testaceous but sometimes with a median oval black spot. The remaining segments are testaceous (Fig. 2). Length 6 to 9 mm., average about 7 mm.

A closely allied western species of this genus has been described by Osten Sacken (17). This species, *Pterodontia misella*, so closely approaches *Pterodontia flavipes* Gray (6) that it is sometimes difficult to determine to which species a variety may belong. Williston (19) says concerning *P. misella* O. S.: "I have several specimens of this species from Washington

varying from six to nine millimeters in length. The black markings of the abdomen vary in extent, and from comparison with eastern specimens (*P. flavipes* Gray), I can find no constant difference and believe them to be the same." From comparisons made by the writer it is noted that the species, *P. misella*, seems to be founded on color pattern alone, for there seems to be no morphological dissimilarity. The only solution to such questions of the identity of a species seems to be by a careful study of a series of specimens which have been reared from known forms.

OVIPOSITION OF PTERODONTIA.

On August 7, while passing by the border of an open hickory grove, the writer observed several large flies hovering up and down the trunks of some large hickory trees. The capture of one of these proved the species to be identical with those reared from the larvæ found on the apple trees. The flies were observed for some time; during this period they hovered up and down the tree trunks from about a foot above the ground to a height of ten to fifteen feet. They flew always on the leeward side and from one to two inches away from the surface of the bark. Occasionally they would come to rest upon the bark, and at such times they were so sluggish that it was possible to pick them up in one's fingers. Though the flies were observed very closely, they were not seen to deposit eggs or to pay any attention to the gray jumping spiders that crept over the bark.

Upon returning to the laboratory and transferring a living specimen to a bell-jar, the writer noted that the handkerchief in which it had been carried was sprinkled with minute black specks, which on examination proved to be eggs. Further observation revealed the fact that the eggs were forcibly discharged from the ovipositor in extremely rapid succession and that the eggs when first deposited were coated with a sticky substance which caused them to adhere to whatever they hit or fell upon.

The following day some of the trees in the grove were banded with narrow strips of clean, white paper. After a brief period two flies appeared hovering over the surface of the bark in the same manner as observed during the previous day. This time, however, with the aid of the white paper strips, their actions were easily interpreted. By watching closely as the flies hovered

over the paper strips, one could see the eggs appear upon the paper as minute black specks sprinkled in irregular rows. An examination of the bark of the trees showed the leeward side of each tree to be literally sprinkled with thousands of eggs. One of the ovipositing flies was so bold as to hurl her eggs on to the face and hands of the writer while making these observations.

The eggs contained in the handkerchief were removed to a watch glass by means of a soft brush. Many of the eggs were lost or crushed during the process; however those remaining numbered 2,300. All of these were deposited by a single female in a period of not more than forty-five minutes.

A second series of egg counts has been made from three females taken July 14, 1916. The counts represent the entire number of eggs deposited by each female from the time of capture until death. They are as follows: No. one, 987; No. two, 3,344; and No. three, 3,977. Most of these eggs were deposited during the morning of the first day, and in no case did the captive flies live for more than two days.

THE EGGS OF PTERODONTIA.

The eggs (Figs. 4 and 5) are very minute, measuring .18 mm. in length and .15 mm. in width. They are slightly compressed and pear-shaped in outline and are of a dull black color. Under high magnification the chorion has a granular appearance as shown in Figure 6. When first deposited, the eggs are coated with an adhesive substance.

LITERATURE ON THE OVIPOSITION AND EGGS OF THE CYRTIDÆ.

Brief notes are to be found concerning the eggs of several European species. Friedrich Stein (18) in 1849 records finding the eggs of *Oncodes fuliginosus* Erich. in mid-June on the stems of *Equisetum limosum* which was growing in a low, wet meadow not far from Berlin. The eggs had been despoited in rows in large numbers and covered the plants thickly. The eggs are described as small, black, pear-shaped bodies. In 1894 König (10) described the eggs and young larvæ of what he thought were those of either *Oncodes gibbosus* or *O. zonatus*, since he took both species in the same locality. The eggs had been deposited on dead branches which had been used to make a fence. The smallest twigs were thickly covered with rows of

dark brown or blackish, pear-shaped eggs deposited so as to stand on the small end. The larvæ emerged from the free end of the egg through a lidlike opening in the shell.

An interesting note on the oviposition of a New Zealand species, *Oncodes brunneus* Hut. (*Henops brunneus*), is given by W. M. Maskell (13) as follows: "About October last a resident in the Wairarapa District sent down to the Colonial Museum a few twigs of apple, quite covered with some black substance, amongst which were slowly crawling about half a dozen rather large flies; and he desired some information on this, which he considered a new 'blight,' stating that it occurred on both apple and peach trees in his garden. The specimens were referred to me, and at first sight I thought the sooty, black coating to be the usual fungus accompanying scale insects, the flies being unconnected with it. Closer examination, however, showed that the black mass was really composed of many thousands of eggs; and the flies were soon observed to be still laying more of these eggs on the twigs, until in a short while it was so thickly covered with them as to be quite hidden."

THE NEWLY HATCHED LARVA OF PTERODONTIA.

From eggs which were deposited on August 7th, larvæ emerged September 7th and 8th, thus making an incubation period of 32 to 33 days. The larvæ made their exit through a lidlike opening at the small, or pointed, end of the eggs. The newly hatched larvæ (Figs. 11 and 12) are Campodea-like in form, resembling quite strikingly the planidium larvæ of Perilampus* or the triungulin larvæ of Stylops. They are dark brown or black in color and measure 0.25 mm. in length, exclusive of the caudal setæ. The body consists of twelve segments including the head.

The head segment is distinct though it is firmly joined to the prothoracic segment. The head appendages consist of two ventral mouth-hooks and two caudo-lateral antennalike setæ. The details of the mouth-parts have not been worked out. There is, however, a large internal pharyngeal skeleton which is very distinct. The latter structure consists of two strongly chitinized dorsal plates (Figs. 7 and 11) and a slightly chitinized

*See Smith, H. S. The Chalcidoid genus Perilampus and its relations to the problem of parasite introduction. U. S. Dept. Agr. Bur. Ent., Tech. Series No. 19, 1912, pp. 33-69.

ventral plate, which is visible only in a lateral view (Fig. 7). The pharyngeal plates seem to fuse and form a median tooth or beaklike rostrum which is capable of being slightly protruded.

The thoracic and abdominal segments are strongly chitinized and consist of distinct tergal and sternal plates. In newly hatched larvæ the body-plates and segments are quite closely drawn together, but in specimens which were removed from their hosts the segments were distended, the terga and sterna being separated by a pleural membrane (Fig. 7). The dorsal and ventral surfaces of the thorax and abdomen are elaborately armed with long and short spines and broad chitinous scales. The dorsal scales are broad and palmate, with nine to eleven points (Figs. 13 and 14). On the dorsum they are limited to the mesothoracic and metathoracic terga, the remaining segments being armed with both long and short spines. There are also a number of minute, round, clear spots, which occur only on the terga. On the venter, the scales occur on all of the sterna except the prothoracic and caudal segments. On the sterna of the second and third thoracic segments and the first abdominal segment the scales are broad and have seven points or digits; the remaining segments are armed with smaller scales which for the most part are three, five, and seven pointed. The scales are firmly set into the body-wall through a funnellike opening (Fig. 16). The caudal end of the eighth abdominal segment is membranous and prolonged, forming a disk or sucker which serves for attachment. On each side of the caudal disk is a long, stiff, spring-bristle which is used in leaping. Spiracles seem to be wanting. On the caudal margin of the eighth abdominal terga are two crescentic areas which resemble spiracles. These, however, are notches in which the caudal setæ, or spring-bristles, rest when the larva stands erect on its attachment disk.

HABITS OF THE LARVA.

The young larvæ are very active, particularly at night when they are in almost constant action. Locomotion is accomplished in several ways. There is a looping movement accomplished by attaching first the head and then the attachment disk in a manner similar to that of a leech. A second method, that of leaping, is effected by the larva standing erect on the attachment disk with the spring-bristles bent at right angles to the

body and toward the dorsal surface; when ready to leap a sudden straightening of the setæ in a posterior direction lifts the larva into the air. In this way the larva can leap five or six millimeters. This method of jumping is quite different from that of the cheese-maggot, *Piophila casei*, and some of the Itonididæ which leap by first bringing the head and tail ends together and then suddenly straightening the body. A third method of locomotion occurs when the larvæ are on a moist surface, when they crawl by extending and contracting the body segments.

On September 10th, the larvæ were separated into two lots and were liberated in large petri dishes which contained bark. A few spiders of the genus Epeira and spider's eggs were also placed in the dishes with the larvæ. In both dishes most of the larvæ died after three days and in five days no living larvæ were found, though the spiders seemed to be normal and fed upon flies for several days.

On September 27th, or 17 days after confinement, one of the smallest spiders was found in a dying condition. The abdomen of this specimen was removed and carefully dissected. Three spiny larvæ were found in the body near the dorsal surface. The larvæ were alive and active and showed no change other than a distension of the body segments.

Some time later the cephalothorax and legs of this same spider were cleared in carbol-xyol and mounted in balsam. This method rendered the thorax almost transparent and enabled one to locate the parasites in their exact position. In all, twenty-seven larvæ were found in the cephalothorax and legs. These were found in the following parts: One in the first segment of the right palp, one in each trochanter of the anterior pair of legs, two in the trochanter of the second right leg, one in the femur of the third right leg, one in the femur of the fourth left leg, one in the patella of the fourth left leg, and the remaining nineteen were in the cephalothorax above the ental openings of the coxæ or near them (Fig. 10).

On November 29, 1915, a second spider died. The death of this specimen was doubtless due to injury received while moving the specimen from Ohio to Illinois, for the thorax was dented and one leg partly crushed; however, it lived for seventy-nine days after it had been put with the young Cyrtid larvæ. This

specimen was too large to clear; hence the entire spider was immediately dissected. One spiny larva was found in the abdomen and three in the thorax. As in the first case, the larvæ were alive and active but no change had taken place. All of these larvæ were carefully examined, and in all cases the spines and scales of the body and the caudal setæ were found to be intact.

Although the foregoing cases of parasitism were brought about under abnormal conditions in the presence of hundreds of larvæ, they manifest several interesting points: First, it would seem from the large number of larvæ found in the cephalothorax thorax and legs of the host that most of the larvæ enter the body of the spider by penetrating the thin membrane at the articulations of the legs. The broad scalelike plates and spines undoubtedly enable the larvæ to penetrate the host and aid in traveling through the muscles of the thorax. Second, the occurrence of first-stage larvæ in the host seventy-nine days after entering, and during November, would lead to the conclusion that the growth of the parasite does not start until after the hibernating season of the host is over. Third, the location of the larvæ in the cephalothorax thorax further indicates that the first-stage larvæ do not have any connection with the respiratory organs of the host. This is further confirmed by the lack of spiracles.

LITERATURE ON THE EARLY LARVAL STAGES OF THE CYRTIDÆ.

Very little has been published concerning the early larval stages of the species of this family and as far as could be ascertained none of the American species have been described. Of the European species only the larvæ of Oncodes have been described. Professor Brauer (2) in quoting from his correspondent, Dr. Gerstacker, states that this observer reared larvæ from the eggs of *Oncodes zonatus*. He does not describe the larvæ further than to say that they were very active and sprang like the cheese-maggot, *Piophila casei*. In 1894, König (10) found eggs and young larvæ of Oncodes. The exact identity of the larvæ is not certain, though he took the species to be either *O. gibbosus* or *O. zonatus*, since adults of both species were taken in the same locality. The larvæ are figured and described in detail. They are described as being 0.3–0.4 mm. long and of a dark brown or black color. The body is made up

of eleven distinct segments, and is armed with setæ. The head is small and not well defined. The mouth-parts consist of two external mouth-hooks, a median tooth and two fleshy lobes, the latter functioning as attaching organs. There are two internal pharyngeal plates. On the caudal segment is a second attaching organ and four short spring-bristles; thus the larvæ move about by a looping movement or by jumping. König states that some of the larvæ were found attached to Podurans.

The larva of a New Zealand species of Oncodes has been figured and described by Maskell (13) in 1888. The larvæ are similar to those described by König. They differ from them, however, in the following points: The body is made up of twelve segments and the head is distinct. There are two mouth-hooks and a fleshy lobe which functions as an attachment organ. The caudal segment terminates in a point with three spines. There are two stout spring bristles and the penultimate segment has two spiracles. The larvæ are said to walk in a looping fashion.

CONCLUSIONS.

From the account herein presented, we may conclude that the method of oviposition of *Pterodontia flavipes* is unique; however, the potential reproductive power of the females seems to be common with other members of the family, as is illustrated by the observations of Stein (18), König (10) and Maskell (13). It is undoubtedly one of the adaptations exacted by a parasitic mode of life in which there is a large percentage of mortality in the first larval stages.

In general the activities of the newly hatched larvæ of Pterodontia are like those of Oncodes. However, morphologically, they are more highly specialized for their parasitic mode of life, as is manifest by the lack of spiracles and by the presence of elaborate scalelike plates on the body.

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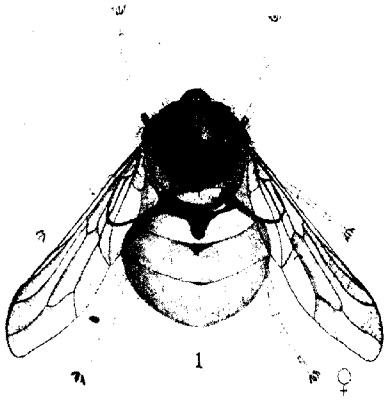

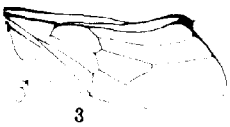

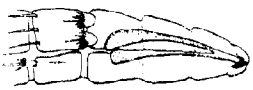

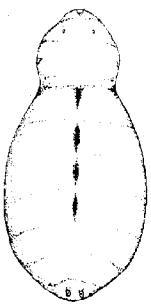

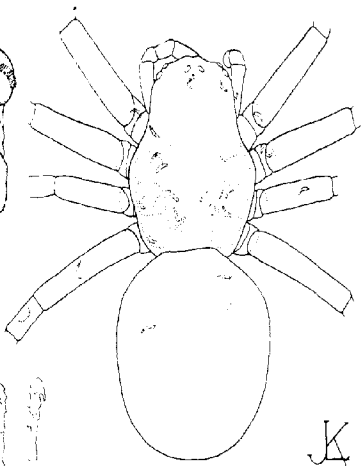

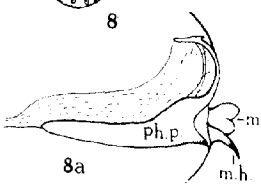

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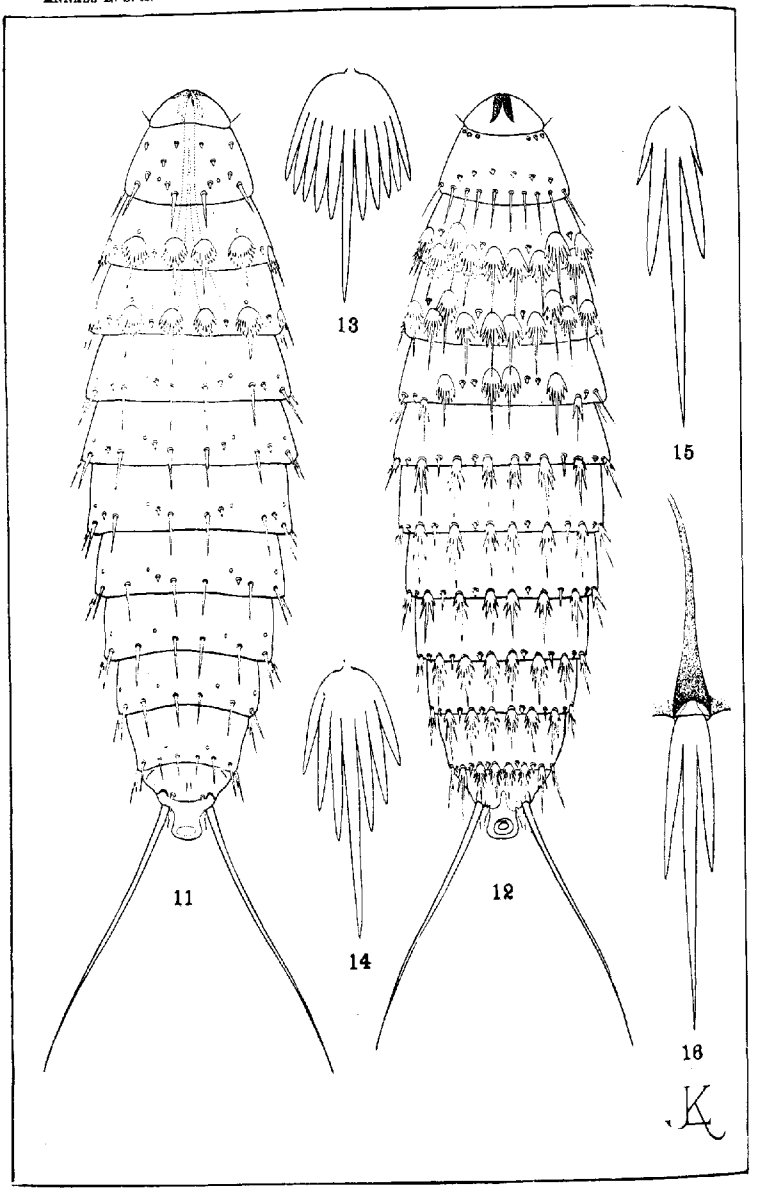

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EXPLANATION OF PLATE XV.

Pterodontia flavipes.

1. Dorsal aspect of female.
2. Dorsal aspect of male abdomen.
3. Wing of male.
4. Egg as viewed from the side.
5. Egg as viewed from above.
6. Chorion highly magnified.
7. Lateral aspect of young larva showing mouth-hooks and internal pharyngeal skeleton.
8. Dorsal aspect of mature larva as it appears after emerging from host spider.
8a. Lateral aspect of mouth-parts. m., mandible; m. h., mouth-hooks; ph. p., pharyngeal plate.
9. Lateral aspect of pupa.
9a. Clublike processes from head of the pupa.
10. Young larvae in the body of Epeirid spider.

EXPLANATION OF PLATE XVI.

Pterodontia flavipes.

11. Dorsal aspect of newly hatched larva.
12. Ventral aspect of newly hatched larva.
13. Scale from mesonotum.
14. Scale from mesosternum.
15. Scale from sternum of third abdominal segment.
16. Scale from sternum of seventh abdominal segment showing its insertion.

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The Foundation announces the acceptance for publication of its first volume, "The North American Species of Sarcophaga and Allied Genera," by J. M. Aldrich. The volume will be printed in time for presentation at the New York meeting of the Society in the holidays. It will make a volume of over three hundred pages with 170 figures on sixteen plates. One hundred and forty-five species are described, most of which are new, the genitalia of 138 species are figured. Many new records of larval habits are given.

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